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John Tyndall.

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, MAY 6, 1875

GEIKIE'S "LIFE OF MURCHISON"

Life of Sir Roderick I. Murchison, Bart., F.R.S. etc. Based on his Journals and Letters. With Notices of his Scientific Contemporaries and a Sketch of the Rise and Growth of Palæozoic Geology in Britain. By Archibald Geikie, LL.D., F.R.S., Director of H.M. Geological Survey of Scotland, and Murchison Professor of Geology and Mineralogy in the University of Edinburgh. 2 vols. Illustrated with Portraits and Woodcuts. (London: John Murray, 1875.)

TO have before us in detail, and reflected as in a mirror of his own notes and correspondence, the story of the life of one who has taken a foremost place in the ranks of science, is a matter of no little interest. We want to know as much as we can of the kind of qualities that go to make a successful man of science, and of the circumstances which have enabled him to be useful to the world. Such information may be obtained either by categorical questions addressed to such men during life, after the manner of Mr. Francis Galton's work lately reviewed in these columns,* in which we have the advantage of numbers for comparison; or by the more detailed story of the life of individuals, from which we can gather for ourselves the answers to our questions, with all the additional light thrown upon them by surrounding circumstances.

Such a story is that presented to us by Prof. Geikie of the life of Sir Roderick Murchison, whom no one will deny to have occupied a foremost place, and to have contributed valuable and lasting materials to the sciences to which he devoted himself. Many, indeed, and fruitful are the teachings of such a life as this, and some of them are well pointed out by the author in his concluding lines.

Nor is the interest of the work confined to this. Not only was Murchison eminent in science, but he ranks among the founders of one of its most recent branches—Geology; and hence, though in later years his name has been more prominently connected in the public mind with Geography, it is as a geologist alone that he will be known to posterity; and the study of his life is an examination of the way in which some of the chief corner-stones of Geology were laid.

Prof. Geikie has performed his promised task in an admirable manner. It must be remembered that he was asked by the subject himself to undertake the work, and the materials out of which he was to develop it were placed in his hands; and under these circumstances he must necessarily be guided partly by the probable wishes of the subject, and partly by the nature of his material; and if it be a biographer's duty to "hold a mirror up to nature," there can be no doubt that Prof. Geikie has admirably done so. The scenes and circumstances that formed so large a part of the acted life may well occupy an equally large share in the written life, however much geologists or students of human nature might wish for different matter.

We have no doubt that Prof. Geikie would have preferred to write such a life as we have indicated, and he has done his best to escape from a "narrative devoted merely to the personal events of Sir Roderick Murchison's life;" but in loyalty to his friend he felt bound, no doubt, to follow his desires rather than his own. Those who are acquainted with Prof. Geikie's other writings need not be told that this is written with admirable perspicuity, and his candour and ingenuousness are above all praise. There is no false colouring here; we see Murchison as he was; what was good not exaggerated, but duly brought forward; what was bad (and who has not faults?) by no means palliated, though, where possible, accounted for. These are undoubtedly the great merits of the work, and ought to inspire thorough confidence where it touches on matters of controversy.

The Life before us gives admirable means of perceiving the exact relation of Sir Roderick Murchison to the science of Geology, and the qualities and circumstances which enabled him to stand in that relation. There are times in the history of a Science, as in the history of a Nation, when some definite work has to be done, and it is done, as we may say, through some power of natural selection, by one whose qualities are adapted for that purpose and for that alone, and whose greatness consists in being exactly fitted in that respect to the time in which he lives, and it may be in nothing besides. Before we consider the relation which Murchison held in this way to Geology, we may pass in review the chief incidents of his life as detailed for us in these volumes.

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* NATURE, vol. xi. p. 161.

Sir Roderick was descended from a sturdy Highland stock, whose courage and perseverance he inherited, but who contributed no further to his fortune. His father was a surgeon, who, after making a fortune in India, returned to his native land and bought the estate of Tarradale, in the eastern part of the county of Ross, where Roderick was born on Feb. 19, 1792. When the boy was only three years old the family removed to Bath, where the father died in 1796. Three years after, Roderick's mother married a second time, and the boy, at the age of seven years, was sent to the grammar school of Durham. Here he seems to have learnt little but mischief; but educational requirements were not great in those days, and he probably knew at the end of his six years as much as most of his contemporaries. Certainly his education here had no manner of influence, as far as we can see, on his future career; and the absence of scientific culture in youth, if it did not prevent him from rising to greatness and doing good work, would most decidedly have done so had he been thrown into other circumstances and lived in days like our own, and it certainly confined him to the limits of a geological worker instead of allowing him to become a geological philosopher.

After leaving Durham, and visiting his uncle, General Mackenzie, who persuaded him he would make a good soldier, he was sent to the military college at Great Marlow. The two years he spent here cannot be said to have been without use to him, for if he learnt but little from books, he was forced to undergo the more special training for a soldier's career, which in after life had a solidifying effect on his character. At this time his uncle wrote of him: "He is a charming boy, manly, sensible, generous, warm-hearted. I think he has talents to make a figure in any profession." At the age of fifteen he was gazetted Ensign in the 36th Regiment, which, after picking up some scraps of knowledge in Edinburgh, he joined in Ireland. He had not long to wait for work, for in the following year (1808) his regiment was ordered to the Peninsula, and he received his "baptism of fire" at the battle of Vimieira. We need scarcely say of any English soldier that he behaved with bravery in battle, and fortitude under trying circumstances: but, after a short display of these qualities, a retreat was ordered from Corunna, and Murchison returned home, being nearly wrecked in the transport. Though he joined his uncle Mackenzie as aide-de-camp in the following year, he never again succeeded in getting into active service, and this induced him, after eight years' career, to retire from the army.

Murchison was evidently a keen soldier, and it seems probable that, had he found adequate scope for the irrepressible energy of his character in this direction, Geology would have lost his services. At the age of twenty-three, on August 29, 1815, he married Miss Charlotte Hugonin, daughter of General Hugonin, of Nursted House, Hampshire; an event which had a more than usual influence on his future career. In the first place, her fortune, combined with his own, enabled him to devote himself to any pursuit he might take up, without having the distractions of bread-winning routine duties, and in later years to keep up that state and hospitality which made him the representative of science in the upper circles of society. But also, and to her honour, she exercised a most salutary personal influence over him, almost imperceptible, but always in the right direction. Prof. Geikie says, "to his wife he owed his fame;" but a perusal of his life assures us that this must be taken in a very qualified sense. Such a steady attachment to science as he showed for more than forty years argues a natural bent that way that would sooner or later have been developed under any circumstances; yet at one time certainly she was his "*better* half," and her influence deserves all admiration. It was soon after his marriage that he retired from the army, chiefly to avoid introducing his wife to the monotony of barrack life. What pursuit was he to follow now? Something it must be that, while it would not engross too much time and effort, would leave him plenty of scope for the satisfaction of that muscular energy which was continually craving for some adequate outlet. Should he become a country parson, trudging for miles over the wild country side to visit some outlying houses, varying his duties occasionally by a fox-hunt or a day's shooting? He actually thought of this; but his creed, as given in his own words by his biographer, shows that this was really an impossible solution of the question. So he tried travel; and for two years roamed over Italy and examined the treasures of art with a quickly ripening critical eye. His enthusiasm in this pursuit, which was quite new to him, proved how vast was his energy, and that it only required guidance into a suitable channel to accomplish valuable work. But he found out in time that art was not his calling; and, tired of continental travel, he brought back his wife to England. Then there was nothing but fox-hunting that he could think of to employ his energies; so he spent five of the best years of his life, from twenty-six to thirty-one, in this important occupation, and succeeded in gaining the glorious distinction of being the best rider in his neighbourhood.

But the wild oats were sown at last, and partly from *ennui*, partly from meeting with Sir Humphry Davy, and greatly from the influence of his wife, he once more looked the question in the face—Was there no employment that would be worthy of a man of energy, that would require and repay his enthusiasm?

At that time (1825) Geology was in need of such a man as he. Some few years before the Geological Society had been started, and its principle was this: "In the present state of geological science, facts are more wanted than theories." Now, while the facts of most other sciences are obtained in the closet, many of those of geology are to be gathered in the field. Prof. Geikie gives in this connection a pleasant outline of the state of theoretical geology of the time, on some details of which there may possibly be difference of opinion, but it is certain that no sound progress could be made on account of the backwardness of stratigraphical geology; almost the only good work as yet done in this direction being that of Wm. Smith—a man considerably like Murchison in character, though in a lower walk of life, and who had mapped and arranged most of what we now call secondary rocks. Much remained yet to be done both among these and above them, but below them was a perfect blank. No one had yet attempted to attack the monster "Grauwacke" in his fastnesses. It was not, however, to be conquered by a tyro, and it was only after minor attempts elsewhere that Murchison made the assault upon it from above, while Sedgwick undermined it from below.

Murchison's life hitherto has not been such as to lead us to expect much of him; but a study of his biography and a knowledge of his works prove that we must from this time see him in a different light; without indeed the advantages of early training, yet earnestly doing his best under the circumstances to advance the cause of science in that way in which alone he could hope to do so. He was one of those who

> "rise
> On stepping-stones of their dead selves
> To higher things;"

and we next hear of him as a diligent student of Brande, Buckland, Webster, and Wollaston, and very shortly following out, at the suggestion of others, some new lines of inquiry, where information was wanted. The discussion of these works we will postpone for the present, and pass on to the sketch of his life henceforth as detailed for us so clearly by Prof. Geikie.

His first excursion was in the summer of 1825, when he was accompanied by his wife, and made a tour of nine weeks on the south coast, from the Isle of Wight into Devon and Cornwall. "Driving, boating, walking, or scrambling, the enthusiastic pair signalised their first geological tour by a formidable amount of bodily toil."

Murchison associated himself early in his geological career with Sedgwick, with whom he had many a happy and profitable tour, the first of which took place in 1827, when they went together to the Island of Arran. Murchison's summers for many years now were spent in the field, while his winters in London were given to society, and to the work of the Secretary of the Geological Society, which he voluntarily undertook. It was not till 1831 that he first broke ground in "Siluria," the results of which appeared after many delays, in 1838, in the well-known "Silurian System." He was not content with work in England only, but quite as often traversed the Continent, bringing home results, and enjoying the society of the chiefs of geology abroad. No sooner was his first work well off his hands than he began to contemplate an excursion to Russia to trace the same rocks there, and having been partially successful in 1840, the next year he surveyed the whole of the Ural Mountains under the auspices of the Emperor, and with the assistance of Count Keyserling and De Verneuil, the results of which survey appeared in 1845 in the magnificent work entitled "Geology of Russia and the Ural Mountains."

From this time Murchison's position in the ranks of geologists was secure. How did he use it? To this there can be but one answer. He used all the influence his position gave him for the advancement of science. His personal energies never flagged; no summer passed but he did good work, which now forms part of the common property of geologists. Each autumn saw him enthusiastically engaged in the work of the British Association, of which he was president in 1846, and in which he ever continued to take a genuine interest. During these years his devotion to the Geographical Society increased, and, as our readers know, he was in the end regarded as so indispensable to its prosperity, that for the last ten years of his life he was president.

This Society was almost of his own making, for it was a very different thing when he joined it to what it was when he died; and perhaps some little feeling of jealousy may be entertained by geologists at the apparent transference of his affections. But it should be remembered that throughout his career Murchison was a pioneer. His works are all masterly outlines of fresh fields; and when by the time that infirmities in any case would prevent him from doing much field-work, he found a large band of geologists working at details throughout Europe. No room was left for such preliminary investigations as his, unless he went by proxy, so to speak, to countries far away; and in the end he was strictly serving Geology, by encouraging Physical Geography; for the former is impossible without the foundation of the latter being laid.

As Director-General of the Geological Survey, a post which he held from the death of Sir H. De la Beche in 1855 until his own decease in 1871, he earned the gratitude of geologists by the enlarged scope he persuaded the Government to give to it, and its consequent rapid and invaluable work; while in this and in other ways he was always ready and anxious to help forward any rising worker in the field.

Into further details of his life—how honours were poured on him from all sides, which he received with avidity; how he never failed to enjoy the delights of society; how he obtained a Geographical Section at the British Association; how he endowed a professorship of Geology—into these we cannot enter more fully, but must refer the reader to the book itself, where they are all admirably set forth.

The last words of Prof. Geikie on the character of Sir Roderick Murchison are very good. He traces the success of his career and the value of his life to three main sources. "Foremost we would place his vigorous energy, his unwearied and almost reckless activity. He never seemed to be without a definite and well-planned task." "Another leading feature in his character . . . was shrewd common sense and knowledge of the world;" and "there was still another characteristic which secured to Murchison the esteem as well as the respect of his fellow-men—his thorough kindliness and goodness of heart." Every one of these features is amply illustrated in the details of his life; and though other features, perhaps not quite so imitable, may strike us on its perusal, yet these stand out in the foreground, and teach the ever-required lesson that industry and energy are the invariable forerunners of success.

(*To be continued.*)

THE FLORA OF BRITISH INDIA

The Flora of British India. By Dr. J. D. Hooker, C.B., assisted by various Botanists. Vol. I. Ranunculaceæ to Sapindaceæ. (London: Reeve and Co.)

THE completion of the first volume of the Flora of India is an event of no small importance in descriptive botany. That India should be almost the last of our possessions whose vegetable wealth botanists have undertaken to describe in a systematic order, is due to various causes, not the least of which is the enormous labour of collecting and sifting the scattered literature bearing on this subject. The books and short papers on the botany of various parts of India are exceedingly numerous, and several works have been commenced never to be completed. Dr. Hooker himself, in conjunction with Dr. T. Thomson, published some years ago the first volume of a Flora of India based upon a more elaborate plan than that of the work now in progress, which departs from that of the other Colonial Floras, Hooker's "Student's Flora of the British Islands" having served as a model.

In addition to British India proper, this work embraces the territories of the Malayan Peninsula, Kashmir, and Western Thibet; but Afghanistan and Baluchistan, having been taken up by Boissier in his "Flora Orientalis," are not included. The total area under investigation exceeds a million square miles, exhibiting every variety of climate, soil, and other conditions, and ranging from the sea-level to an altitude of 19,000 feet, which is about the upper limit of flowering plants. Dr. Hooker computes the total number of species growing within this area at 12 to 14,000, which is doubtless not very wide of the mark, judging from the number reached up to the end of the *Sapindaceæ*.

In the first place we will give a glance at the contents of the present volume, which forms about a sixth part of the whole work. Exclusive of an index of forty pages, it extends to about 700 pages, and includes descriptions of 2,250 species under 442 genera, belonging to forty-four natural orders. These figures do not take in introduced plants incidentally mentioned or fully described. Contrasting these numbers with those afforded by the flora of tropical Africa up to the end of the *Sapindaceæ*, we obtain some idea of the relative richness of the vegetation of tropical Asia, especially if we bear in mind that the area of tropical Africa is more than six times the extent of India. True, African vegetation is not so well known, but future discoveries in the respective countries will probably not materially alter the proportions. The numbers for tropical Africa, which we have added up in Oliver's "Flora of Tropical Africa," are 945 species in 250 genera, and forty-five natural orders. It will be seen that the number of natural orders is almost the same, one more being represented in Africa than in India. A very large proportion of the species enumerated in the volume before us are exclusively Asiatic; we have not made an exact calculation, but should estimate it at ninety per cent. Of the 442 genera, 164 are, so far as our present knowledge goes, peculiar to Asia. The greater part of the peculiar genera are tropical, and many of these, doubtless, still remain to be discovered in New Guinea and tropical Australia. The mountains of Northern India have furnished our parks and gardens with many useful and ornamental trees, &c.; e.g., *Cedrus Deodara* and *Pinus excelsa*; and many others might be introduced with a view to profit or pleasure. In most cases, where possible, Dr. Hooker gives the altitudes at which the species are known to occur; but of course this part must still be imperfect. We have made a list of those species reported as growing *above* 10,000 feet, and it includes nearly 250 species, or about a tenth part of the whole number. These belong chiefly to the *Ranunculaceæ*, *Cruciferæ*, and *Caryophylleæ*, and contain a large number of endemic species; the remainder being chiefly common either to Siberia or the Alps of Southern and plains of Northern Europe, including many common British plants. We will not trouble the reader with many more figures, but we may select a few more to give a general idea of the vegetation up to the point reached in this volume. Taking two or three examples of those orders consisting mainly of herbaceous plants or climbing shrubs, we have *Ranunculaceæ*, 115 species, or 5·2 per cent; *Cruciferæ*, 137 species, or about 6 per cent.; *Caryophylleæ*, 104 species, or 4·6 per cent.; and *Geraniaceæ*, 165 species, or 7·3 per cent. Turning to the woody orders which characterise the tropical and sub-tropical regions, we have *Anonaceæ*, 190 species, or about 8·5 per cent.; *Dipterocarpeæ* (an almost exclusively Asiatic family), 92 species, or about 4 per cent.; *Guttiferæ* 61, *Tiliaceæ* 109, *Meliaceæ* 83, *Olacineæ* 66, *Celastrineæ* 105, and *Sapindaceæ* 70 species. Among genera numerous in species we may mention *Capparis Garcinia*, *Grewia*, *Impatiens*, and *Vitis*. Considerably more than a hundred species of *Impatiens* are described, and about 75 of *Vitis*; seven of the former genus ascend above 10,000 feet, and nearly all of them are very restricted in their geographical area. In tropical Africa there is about the same number of species of *Vitis*, but only one or two are common to both regions, the others being endemic.

So far we have confined ourselves to an attempt to indicate the interest of the work as a contribution to phytogeography; its usefulness in applied botany cannot be over-estimated. It would not be difficult, it is true, to point out a great many little defects and inequalities in elaborating the materials at their disposal by the different contributors. But those whose experience is least in this branch of botany are aware of the difficulties encountered at every step. In the first place, the limitation of species must be more or less arbitrary, and it is by no means an easy task to settle the limits, in this case especially, on account of the large number of forms described as species by botanists of all nations in innumerable books and journals. The view here taken of species is a broad one; hence we find that there is an average of two synonyms to each species, and in some instances the array of names is something quite formidable. Of course many of these synonyms result from individual views respecting generic limits. As to genera, there is little deviation from Hooker and Bentham's "Genera Plantarum," though an examination of a large number of specimens has frequently necessitated a modification of the diagnoses of certain genera. As to "polymorphous species," the forms readily distinguished are briefly characterised as varieties; but it is assumed that the extreme forms collected under one species are united by every intermediate gradation, so that it is not possible in practice to say to which variety some forms should be referred. We have already mentioned that Hooker's "Students' Flora" has been followed mainly in the style of arranging the matter, and this no doubt is an improvement in some respects on the Colonial Floras; but the absence of keys to the species of each genus, in our opinion, is not compensated for by the change. In the "Students' Flora" the synonyms are given in italics, and readily catch the eye; but in the "Flora of India" they are printed in the same type as the descriptions, and are difficult to find, especially as one is so unaccustomed to this method. Under each genus and species the geographical area is given, and in most cases pretty fully; but most of the numerous discoveries in tropical Australia since the publication of the "Genera Plantarum" have been overlooked: we allude to those already published in the "Flora Australiensis." Other little slips of this sort occur. For instance, there is a species of *Berberis* in Abyssinia.

Dr. Hooker has contributed largely to this volume, and the following botanists have assisted:—Dr. M. T. Masters, *Malvaceæ*, &c.; Mr. W. P. Hiern, *Sapindaceæ*, &c.; Prof. W. T. T. Dyer, *Dipterocarpeæ*, &c.; Prof. Lawson, *Ampelideæ*, &c.; Mr. A. W. Bennett, *Polygaleæ*; Dr. Anderson, *Guttiferæ*; and Dr. T. Thomson and Mr. M. P. Edgeworth were also associated with Dr. Hooker in the elaboration of certain orders. A comparison of the work of the different contributors brings out the defects of some rather strongly, but it would obviously be unfair to single them out, because they have not done quite so well as the best.

This is a good solid instalment towards a portable flora of India; and with so numerous a staff of botanists, well qualified for the task, we may confidently hope that the work will proceed with tolerable rapidity. True, the first part of this volume appeared in 1872, but we anticipate a better rate of progress for future volumes.

OUR BOOK SHELF

Proceedings of the London Mathematical Society. Vol. V. 150 pp. (London: Hodgson, Gough Square, 1875.)

FORMER volumes of these Proceedings have embraced the Transactions of two and even of three sessions; this contains the Transactions of one session only; hence the smallness of the volume. The longest paper in it is a valuable geometrical memoir, by Dr. Hirst, "On the correlation of two planes." When the points and right lines of two planes are so associated that to each point in one of the planes and to each line passing through that point, respectively correspond, in the other plane, *one* line and *one* point in that line, then a correlation is said to be established between the two planes. The author indicates in a note how his results are also all applicable to the case of two homographic planes.

Prof. Cayley contributes papers on Steiner's Surface and on certain constructions for bicircular quartics. Lord Rayleigh has a note "On the numerical calculation of the roots of fluctuating functions." Mr. J. W. L. Glaisher writes "On the transformation of continued products into continued fractions." Mr. C. J. Monro has a note "On the inversion of Bernoulli's theorem in probabilities." Mr. Samuel Roberts also contributes a note "On the expression of the length of the arc of a Cartesian by elliptic functions," and "The parallel surfaces of developables and curves of double curvature;" Mr. Spottiswoode has a paper "On the contact of quartics with other surfaces;" and Mr. H. M. Taylor "On inversion with special reference to the inversion of an anchor-ring or torus." Interesting papers of a more elementary character are contributed by Mr. J. Griffiths "On the Cartesian equation of the circle which cuts three given circles at given angles," and "On a remarkable relation between the difference of two Fagnanian arcs of an ellipse of eccentricity e, and that of two corresponding arcs of a hyperbola of eccentricity $\frac{1}{e}$;" and by Prof. Wolstenholme "On another system of Poristic Equations."

So far we have cited those memoirs only which treat of pure mathematics. There are, besides, papers by Mr. Röhrs, "On spherical and cylindric motion in viscous fluid;" by Mr. Routh, "On stability of a dynamical system with two independent motions," and "On small oscillations to any degree of approximation;" by Prof. Clifford, "On graphic representation of the harmonic components of a periodic motion;" by Prof. Crofton, "A method of treating the kinematical question of the most general displacement of a solid in space;" by Mr. Merrifield, "On the determination of the form of the dome of uniform stress."

Here is, as usual, sufficient variety for differing tastes dished up by the most advanced mathematicians in this country; other names also occur as contributories of communications, though their communications do not appear in this volume, notably those of Professors Sylvester, H. J. S. Smith, and J. Clerk-Maxwell. Further, a communication by Mr. A. J. Ellis, we are informed, took the shape of a separate pamphlet, entitled "Algebra identified with Geometry." This pamphlet arose out of Mr. Ellis's connection with the Association for the Improvement of Geometrical Teaching, and copies were kindly presented by him to the members of the two societies. It is procurable at the above-named publishers of the Mathematical Society's Proceedings.

Fiji: our New Province in the South Seas. By J. H. De Ricci, F.R.G.S. With two Maps. (London: Stanford, 1875.)

MR. DE RICCI'S book has the appearance of having been put together hastily, to catch the mild and short-lived excitement connected with the annexation of Fiji. A large proportion of it consists of extracts from other works thrown together without much attempt at systematic arrangement; the result is a somewhat undigested mass of facts and figures about Fiji. Still, the book does contain a great deal of useful and interesting information, and will give its readers a very fair idea of the history and the physical and social condition of our most recent annexation. The information given may be regarded as trustworthy, as it is taken from the works of Wilkes and Seemann, and from various official documents. Appended are lists of the native names of timber-trees and of the fauna; but very much more valuable is the long systematic list of all the Fijian plants at present known, compiled partly from previous writers and partly from the author's own observations. The two maps add to the value of the work—one of the Fiji Archipelago, and the other showing the position of the colony in reference to America, Asia, and Australia.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Geology in America

I AM somewhat chagrined to find that I appear to you (vol. xi. p. 381) to say that the Geological Survey of Great Britain is especially to blame for the diminution of interest in geology in the country that has done the most for its advancement. My remarks were taken down by a reporter, and I have not seen them in print. The point I sought to make was to the effect that in all matters relating to geology, Massachusetts could not do better than to follow the lead of the British Survey. The only question to be considered was whether it was not open to criticism from an educational point of view. On this matter I expressed no individual opinion, but only restated doubts that I had heard expressed by more than one of your own masters in the science. I feel that geological science owes so much to your noble Survey, that none of its students should subject it to hasty criticism. If it is to have its methods questioned, it should be done by some one far better acquainted with its ways than any person from another country is likely to be. It seems to me, however, that the diminution in the number of geologists, compared with the students of other sciences, if not in absolute number, is clear on simple inspection of the field. It is true not only of Great Britain, but of France and America as well. Of mining engineers there is, I believe, a great plenty; but of men who are trained in field work, who can be trusted to unravel a set of rocks, or who care for the science as a science, and not as a means of winning a living, there are far too few.

A year ago I had to organise a geological survey in the State of Kentucky. I needed three topographers and three assistant geologists who could stand alone. I picked my topographers from over a hundred competent applicants; I should have searched in vain for months for two of my geologists, had it not been that the suspension of the Missouri Survey gave me trained men. But for this I should have been driven to Germany, that inexhaustible reservoir of trained men, for my helpers. In our schools it is still worse: geology is taught in the air, not on the earth. The student never gets into the field for practical work, and the science remains for him a thing of names and shadows. With the hope of doing something to remedy these evils, there is to be a Summer School of Geology, intended for teachers of geology and those who propose to make special workers in the science, taught in connection with the work of the Kentucky Geological Survey; it will be, in fact, though taught in Kentucky for the present, the Harvard Summer Term in Geology, all the instructors in that department from this University taking a part in its work. Eight or more of the assistants of the Kentucky Survey will also be employed as instructors. Already over one hundred persons have applied for admission to the school, but the number will be limited to thirty: this list now includes twenty-five teachers of schools of academic grade, and five graduates of colleges who propose to become geologists. As the school will be placed in a camp, it will be possible, if it succeeds, to establish it in a new region each year, so that teachers attending for, say, three years in succession, may get a fair notion of our rocks, and, what is better, learn how to do field work. I believe that the novelty of the life, the freedom and fresh air, will make it possible for teachers to use their vacation time in study without damage. I am not without hope that in this way teachers may be trained to their work, and beginners provided with that practical introduction to geology which it is now so hard to obtain. N. S. SHALER

Harvard University, April 18

[We append the programme of the Summer School of Geology referred to by Prof. Shaler, in the hope that something similar may be inaugurated here.]

HARVARD UNIVERSITY.

Summer Instruction in Geology, 1875

In order to furnish an opportunity for teachers in natural science and special students in Geology to become acquainted with the methods of practical work in that science, a Summer School of Geology will be established, during the months of July and August, at a camp near Cumberland Gap, in the State of Kentucky. This place has been chosen on account of the eminent advantages it offers for the study of a great section of the American Palæozoic rocks, and of the structure of the Appalachian Mountains, and on account of the co-operation of the Kentucky Geological Survey which is promised in a letter from the Governor of that State to the President of the University. It is also a very healthy region.

The special object of this school will be to teach students to observe, but instruction will be provided in Physical Geology, Historical Geology and Palæontology, Chemical Geology, and Topographical Engineering, as far as these subjects are connected with geological work. The instruction will be necessarily incomplete, and will be expressly directed to the elucidation of the problems furnished by the area to be explored. The co-operation of six well-qualified instructors has already been secured, and a number of other able geologists have promised their presence and their aid in teaching. Some instruction in the zoology and botany of the neighbouring region will probably be given to those who desire to receive it. Certificates of attendance will be given at the end of the time. The number of students will be limited to thirty, and men only will be accepted. No previous knowledge of the science is required, but only graduates of colleges, teachers, or other persons who can give evidence of maturity and some training can be admitted.

Persons wishing to join the school should at once address J. W. Harris, Secretary of Harvard College, Cambridge, Mass. Before their enrolment they will be required to pay the fee of fifty dollars for tuition, use of tents and camp equipage, and transportation about camp. In case anyone is prevented from joining the school by illness this fee will be remitted, provided the notice thereof is given before June 15. They will also be required to pay weekly in advance the estimate for subsistence and camp servants (which is not expected to exceed three dollars per person).

Persons joining the school from the west will report themselves on June 24 and June 30, at the terminal station on the Lebanon Branch of the Louisville and Nashville Railroad. Those joining from the east will be met at a station hereafter to be designated on the East Tennessee Railroad, on June 26 or July 1. Persons unable to join on these days should notify the chief of camp, Mr. John R. Proctor, Lexington, Ky., who will arrange for their transportation to camp.

All students are expected to provide themselves with the following articles:—Two blankets, a pocket magnifying-glass, a pocket compass; Dana's "Manual of Geology," revised edition (1874), and Lyell's "Principles of Geology." Suitable notebooks will be provided at cost. Students should also provide themselves with two suits of old clothes, flannel shirts, and stout boots. The total amount of baggage should not exceed seventy-five pounds for each person. An effort will be made to secure a reduction of fares on the railroads leading to the camp.

The Attraction and Repulsion caused by the Radiation of Heat

WILL you allow me to say a few words in reference to the report of Mr. Crookes's paper which appeared in NATURE, vol. xi. p. 494. Apparently Mr. Crookes does not understand the nature of the forces which I have shown to result from the communication of heat between a gas and a surface; otherwise he would not bring forward as conclusive against the supposition that the phenomena which he has discovered are due to these forces, experiments which show entirely the other way. As I have previously explained, it follows as a direct result of the kinetic theory of gas, that if such forces as I have supposed exist for a certain tension of the gas surrounding the surface, they will not be diminished by diminishing the tension of the gas; and consequently no amount of pumping would destroy such forces where they once existed. Whereas the smaller the tension of the gas the freer the surface will be to move, and the less its motion would be opposed by convection currents; hence, on the supposition that the motion is due to these forces, the only effect of improving the vacuum would be to intensify the action. And this being the case, it is clear that Mr. Crookes's experiments, in which he finds that the action still remains in the most perfect vacuum which he has obtained, tend to support and not to upset my conclusion that the actions are due to these forces. The fact that Mr. Crookes finds it impossible to conceive this only shows, as I have said, that he does not comprehend the nature of the forces; for it certainly presents no greater difficulty than the fact that the velocity of sound is independent of the tension of the gas through which it is transmitted.

Mr. Crookes still appears to think that I attribute these forces solely to the presence of condensable vapour. It is true that the title of my first paper might have led him into this error had he read no further; but both in that paper and in a letter to the *Philosophical Magazine* for November 1874 it is clearly shown that this is not the case.

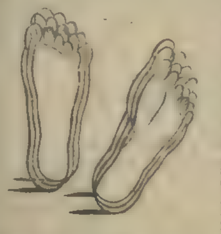
I am in hopes that ere long we may hear something on this subject from Prof. Maxwell, who probably knows more about the kinetic theory of gases than anyone else. If I am right, these experiments afford a direct proof of the truth of this theory; and as far as I know, this is the only direct proof that has ever been obtained. I do not mean to say that this is the most conclusive proof, but the most direct, or, to quote a remark of Dr. Balfour Stewart, "These experiments stand in much the same relation to the kinetic theory of gases that Foucault's pendulum occupied with regard to the rotation of the earth." No one can admire more than I do the experimental skill with which Mr. Crookes has brought the phenomena to light; nor can I see, should it turn out as I maintain, that they have led to the discovery of a law of nature, that this will detract from their importance, even if they lose somewhat in general interest from the breaking up of the halo of mystery with which they have hitherto been surrounded. OSBORNE REYNOLDS

Owens College, Manchester

The *Rôle* of Feet in the Struggle for Existence

MAY not the "set" of the feet in various races of men have played a not unimportant part in the struggle for existence? In thinking over the subject the following points have occurred to me, and perhaps some of your readers may be able to throw some further light on the question.

In the case of the North American Indian, for example, except that he wears soft mocassins instead of stiff boots, he is less in a state of nature as regards his feet than we are. For we, and all the Teutonic tribes for countless generations, have paid little regard to our feet except as instruments of unconscious progression or as pedestals on which to stand firm. The North American Indian, on the contrary, is obliged by his habits of life, and has been obliged for hundreds, perhaps thousands of years, to direct his particular attention in no small degree to the position of his feet. For in hunting it is of the greatest importance that he shall not tread on any rotten stick which may snap with a loud noise and alarm the game of which he is in pursuit. On the war track it is of equal importance that he shall deceive his enemies as to the number of his party, and so each man carefully steps in the footprint of the warrior who had preceded him. This, I should think, would be decidedly easier if the foot were kept pointing straight fore and aft than if it were held obliquely. This may be more evident from the three rough outlines I have drawn of footprints in each position, in which I have made the difference in the length of the stride much the same. Indeed, the difference is greater in the fore and aft one, and yet the impression made by the three footprints will not be so large as when the foot is oblique. In walking in snow-shoes, too, the feet must be held as nearly as possible parallel, as otherwise the shoes are apt to catch in each other and trip their wearer up. It seems quite possible that long-continued attention to the position of the feet for many generations, together with the advantage which a parallel position of the feet may have conferred in the struggle for existence, may have led to its becoming a permanent characteristic of the Red Indian; while the advantage which the outward direction of the feet may have given the old Saxon, by affording a firmer support in a hand-to-hand struggle, may have led to its permanence in the successors of those who possessed this peculiarity, and by its means enabled them to overcome their opponents.



I cannot be quite sure about the ancient Egyptians. If I remember rightly, the Farnese Hercules has toes pointing considerably outwards, while Mercury generally has his feet more or less parallel. This would indicate that the Greeks associated the former position with strength and firmness, and the latter with fleetness. As fleetness will also aid the North American Indian in the struggle for existence, it is possible that its association with a parallel foot may have something to do with the peculiar formation of his ankle-joint. This, however, leads us to the question which I do not think has ever yet been taken up: In what way does the possession of a certain kind of weapon and the use of particular methods of warfare influence the conformation of the body? Have the descendants of the Teuton tribes toes which point outwards because their forefathers used clubs, axes, and targets, and have the Red Indians of the present day parallel feet because their forefathers used arrows and keen tomahawks, and trusted to agility rather than to brazen studs and thick bull-hide for escape from the blows of their adversaries?

X.

Destruction of Flowers by Birds

A WELL-OBSERVED case of the destruction of primrose flowers by birds will perhaps be of interest to some of your readers.

The flowers of two plants of primrose at a short distance from a window have during the last few days been almost entirely destroyed; and this having drawn attention to the subject, they have been watched. The result is that a number of the common house-sparrows have been seen to peck off the flowers by cutting them through at the base of the tube of the corolla, so as to remove the ovarium. In some cases the flower has not been completely detached from its stalk, a ragged hole being left where the ovarium originally was placed, but the flower has never been subject to any further dismemberment. The few flowers which have been left on the plants, when chewed in the mouth, do not seem to have any sweetness about them, and one would therefore suppose that they do not contain any appreciable quantity of nectar.

The inference from these observations seems to be that the sole object of the destruction of the flowers is to obtain the ovaria. It is also to be observed that the primrose is not indigenous to this part of the country, and the only plants within a radius of at least two miles are those cultivated in gardens. The cowslip is, however, very abundant, but I have never noticed any similar destruction of it. I shall, now the cowslips are coming into flower, watch them with the object of finding out whether they are attacked or not.

H. GEORGE FORDHAM

Note on the Common Sole

IN looking over Mr. Buckland's last work on "British Fishes," I did not find any account of the power the Sole has of fixing itself against the glass of an aquarium by means of a sucker placed close to the mouth, on the lower side; and as I find it is one of the "things not generally known," I think it may be worth your notice, particularly as I have not remarked it at the Brighton Aquarium. I first observed the fact at the Havre Aquarium, where I pointed it out to many persons hitherto unacquainted with it, but I have been disappointed at not seeing it at Brighton during any of my visits. The only way I can account for this difference in the habits of the same fish is that the Brighton Soles being, during my visits, always in the light, lay quietly at the bottom, whereas those at Havre, being almost excluded from the light, were seen to much greater advantage, swimming about freely and attaching themselves to the glass when they came in contact with it, or sliding down to the ground. The sucker of a Sole nine inches long would be about $\frac{3}{4}$ inch by $\frac{1}{8}$ inch, placed diagonally to the long diameter of the fish, and exhibiting fine radiating lines. Though I watched other flat-fish carefully, I never could detect any attempt in them to fix themselves against the glass when they struck it, and therefore I am quite unable to explain why the Sole alone should have this power. As I make no pretension to be an ichthyologist, it is very probable that I may be telling a thrice-told tale. I must therefore leave it to your judgment to decide whether it is worth your notice in NATURE.

T. OGIER WARD

Eastbourne

Colour in Goldfinches

LAST July I took a goldfinch's (*Carduelis elegans*) nest with five young birds in it out of a tree in my garden and brought them up. Four turned out to be properly marked specimens, but the fifth is almost black, only having a few red feathers on its head. I see in Bechstein's "Cage Birds" (third edition), p. 147, that "four young ones of this variety were found in the same nest." Now, why were not all my five specimens black, and what is the cause of the fifth's blackness? Can any of your readers say?

Manley, May 1 LUCIE WOODRUFFE

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—The two following stars require further examination, as affording signs of fluctuating brightness. (1) Lalande 23228 9, estimated 7th magnitude, 1795 May 8, and $5\frac{1}{2}$, 1798 March 14. It is 6·7 in Lamont (No. 1149), and in Steinheil's Chart, one of the series published by the Berlin Academy, it is only 8th mag. Neither Bessel nor Santini has observed it. (2) The star Lalande 27095, in Boötes, 7th mag., observed 1795 May 25, and missed by Olbers, 1804 March 22, during his observations of the comet of that year: it is the star which passed the centre wire at 14h. 42m. 10s. (Histoire Céleste, p. 164), and Olbers distinctly says of it "ist nicht mehr am Himmel zu finden." It was, however, observed by Bessel in his Zone 415, 1828 May 24, as a 9th magnitude; it is 9·0 in the "Durchmusterung," and is called 9·1, 1866 June 5, in the Bonn Observations, vol. vi. The positions of these stars for 1875·0 are:—

(1)	R.A.	12h.	18m.	45s.	N.P.D.	100°	54′·9
(2)	"	14	45	54	"	52	6·3

The Binary Star Σ 2107.—This undoubted binary, first measured by Struve in the year 1828, well merits attention, and it may soon be possible to gain an idea of the form of the orbit. The recent measures of Dembowski and Barclay prove the angular velocity to be still increasing, the accompanying diminution of distance requiring pretty large telescopes to be brought into requisition for satisfactory observations. Dembowski calls ǝqʇ principal component a 7th magnitude, bright yellow; the smaller one a 9th and dusky. This star is Herculis 197 (Bode), and its place for 1875·0 is in R.A., 16h. 46m. 54s.; N.P.D., 61° 7′.

High-latitude Phenomena.—Our correspondent "H. F. C.," who writes from San Francisco, California, with regard to a statement in the recently-published narrative of the "German Arctic Expedition," that "the moon shone without setting for several days" in November, refers to a phenomenon which must necessarily occur in circumpolar latitudes. As an illustration: In lat. 82° N. and long. 60° W., near which position a part of the expedition about to leave our shores is expected to winter, the moon in December next will rise on the 8th, and will not set until the 18th, attaining her greatest altitude above the horizon at meridian passage on the 13th. The sun during this interval is, of course, invisible in lat. 82° N., but there is continuous moonlight for between nine and ten days, and similarly for other months during the Arctic winter.

The Solar Eclipse, 1876, March 25.—This eclipse will be a very similar one to that of March 1858, which created so much interest in its passage across this country: it will be annular, but in those parts of the track of central line, where the augmentation of the moon's geocentric semi-diameter is greatest, the eclipse, though still annular (as in England in 1858), approaches very near a total one. Vancouver Island is situate in this track, which runs about centrally over it, as the following points will show:—

Longitude	127° 6′ W.	Latitude, 48° 42′ N.
"	126 4	" 49 30
"	125 51	" 49 40
"	125 15	" 50 6
"	122 46	" 51 50

A direct calculation for the third of the above points, in Vancouver Island, gives for the duration of the *annulus* only 7·5 seconds, the middle at 0h. 25m. 29s. local mean time with the sun at an altitude of 44°: the apparent semi-diameter of the moon is 1″·5 less than that of the sun. The central line subsequently traverses the Lesser Slave Lake and Lake Athabasca, with slightly longer duration of *annulus*. The eclipse will be visible in its partial phase in the position of the winter quarters at which the British Arctic Expedition aims.

The Minor Planet "Lydia."—M. Leverrier's *Bulletin International* of April 29 contained a telegraphic notice of the discovery of a supposed new member of the minor planet group, at the Observatory of Toulouse, by M. Perrotin, on the same morning, which in the following *Bulletin* is recognised as No. 110, Lydia, detected by M. Borrelly at Marseilles on April 19, 1870; the ephemeris (*Berliner Jahrbuch*) being much in error. The elements of No. 110, calculated by Dr. Oppenheim of Königsberg, and brought up with perturbations to 1874 (*Astron. Nach.*, No. 1,971), give a position for April 28, differing considerably from that assigned by the observation at Toulouse; but if we apply a correction to the mean anomaly of + 1° 21′ 57″, the observed and computed longitudes agree, and the latitudes differ only one minute, and the diurnal motions also accord, so that there can be little doubt that the identification of M. Perrotin's object with No. 110 is correct. With the above correction the mean anomaly, April 28·5 Greenwich mean time, is 262° 8′ 27″, and thus with the other elements given by Dr. Oppenheim we have the following positions, which will be pretty near the true ones. At 12h. Greenwich mean time:—

		R.A. h.	m.	s.	N.P.D. °	′	Log. distance.
May	3	15	4	17	105	29·5	0·2498
"	5		2	27	"	25·8	
"	7	15	0	36	"	22·2	0·2481
"	9	14	58	45	"	18·5	
"	11	"	56	54	"	14·9	0·2476
"	13	"	55	4	"	11·3	
"	15	"	53	15	"	7·8	0·2482
"	17	"	51	28	"	4·4	
"	19	14	49	42	105	1·2	0·2499

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*LECTURES AT THE ZOOLOGICAL GARDENS**

Mr. J. W. Clarke on Sea Lions and Seals

II.

The Sea Lion that is best known is the Northern Sea Bear (*O. ursina*), which is almost entirely confined to the Pribylov Islands. These islands were discovered in 1787 by a Russian sailor of that name. The slaughter of the animals is under the regulations of the United States Government. There are two islands, that of St. Paul and that of St. George, and the number of seals that have been calculated to exist in a given year upon one of them—namely, 1,152,000—will give a good notion of the multitudes of these animals to be met with at one of their favourite haunts. There is about half that number on St. George, making nearly 2,000,000 on the two islands. Out of this vast number, 100,000 are annually killed, principally young males. In South Shetland the "take" of fur seals was 320,000 in 1821 and 1822, and as all that arrived were killed, the speedy extinction of the colony was the result. The same happened in New Zealand.

A full-grown male *Otaria ursina* is between seven and eight feet long, the female not being more than four feet. The males reach their maximum size at about the sixth year, the females at the fourth. The hairy coat consists of an outer covering of long, flattened, coarse hair, beneath which is a dense coating of long, fine, silky fur.

The next species is Steller's Sea Lion (*O. stelleri*), named in honour of its discoverer. It is much larger than the other species, the males being as much as sixteen feet long. The ears are short and pointed, much broader than those of the Fur Seal. It is found on the island of St. Paul, extending down the coasts of Kamschatka and California. At San Francisco it inhabits an island in the harbour where Mr. Woodford has built a large hotel, to which parties resort to dine and look at the Sea Lions play. The under-fur of this species is so short as to be useless for clothing purposes.

There is another Otaria on the Californian coast, found in Japan also. It was first described by Schlegel from specimens collected by Siebold. It has been named *O. gilliespii*, but it would be far better to adopt the name since suggested by its original describer, and call it *O. japonica*. It is much smaller than the species named after Steller, and the skull presents an exceptionally large crest.

The next species to be mentioned is the one which extends round South America, from Peru to the River Plate—*Otaria jubata*—of which a specimen is living in the Gardens, having been obtained by its keeper, François Lecomte, from the Falkland Islands, when a mere pup. A full-grown male may reach nine feet in length, the females being much smaller. The fur is of no use for sealskin, as the undercoat is very scanty. The male has a mane, and is therefore called "Lion."

Inhabiting precisely the same localities, round Cape Horn and the Falkland Islands, is the Fur Seal of commerce—*Otaria falklandica*. It is much smaller than the other species, a full-grown male being hardly more than four feet long. It is probable that it is identical with one of the New Zealand Fur Seals, described by Dr. Gray as *Otaria cinerea*. If this should turn out to be the case, it will have a wider range than any of the others of the group.

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* Continued from vol. xi. p. 514.

There is certainly another species of Sea Lion on the coast of New Zealand, called Hooker's Sea Bear—*Otaria hookeri*. Its only certain habitat is the Aucklands. It is a large species, the males about six feet long, the females proportionately smaller. Though these New Zealand coasts and islands, together with the coasts of the mainland of Australia, have been visited and surveyed in every direction by English expeditions, no one has ever thought of preserving specimens for museums, so that we really know less about the seals of our colonies than we do about those of foreign coasts. Thus there is certainly a large species on the west coast of Australia, at the group of islands called Houtman's Abrolhos, described by Dr. Gray as *Neophoca lobata*. We are almost equally ignorant about the Sea Lions of the Cape of Good Hope. The species from that locality living in the Gardens—*Otaria pusilla*—is a very small one with an excellent fur. The Antarctic Sea Lion—*Otaria antarctica* (Gray)—is also from the Cape. This completes the number of species of Otarias, which may be thus tabulated :—

OTARIA	
Pusilla *Antarctica*	from South Africa and the adjacent islands.
Jubata *Falklandica*	from Cape Horn and the adjacent islands.
Japonica *Stelleri* *Ursina*	from the North Pacific.
Hookeri *Lobata*	from Australia and New Zealand.

In some respects intermediate between the Sea Lions and true Seals, is the Walrus, an animal with the head flattened in front, the upper lips with long stiff whiskers, the two enormous tusks, the short bull-like neck, and the vast carcase. Stuffed specimens err in being too distended and smooth, all the natural wrinkles being removed. The hair is thin and short. The attitude resembles in the main that of the Sea Bear, as do the limbs, the thumb being the longest digit, and the hind feet directed forward. There are no external ears, but a fold of skin above the auditory opening. The eyes, destitute of lashes, are deeply set. The tusks, developed in the female as well as in the male, never exceed twenty-six inches in length, including the imbedded root of six inches. The creature is omnivorous. It is becoming very scarce in its favourite haunts, on account of the indiscriminate way in which it is slaughtered. Upwards of 1,000 are still taken annually in the neighbourhood of Spitzbergen. Formerly it was found at Bear Island and on the coast of Finmark. It is still found on the east coast of Greenland, on the west shore of Davis' Straits, about Pond's, Scott's, and Howe Bays. In 1775 they resorted, to the number of over 7,000 a year, to the Magdalen Islands, at the mouth of the St. Lawrence, and the English once had a fishery at Cape Breton. It can be mentioned only as a straggler to our coasts.

Every part of the animal is of value—the tusks, the hide, and the flesh. The word *Walrus* means "Whale Horse," *Ross* being the Danish for a steed. *Morse* is Russian. The Greenlanders call it *Awŭk*, a name derived, it is said, from the cry of the young animal.

Seals are in a state of far less confusion than Sea Lions. The species are numerous, Dr. Gray recognising fourteen species and thirteen genera. As a basis for classification, the number of incisor teeth, together with the shape of the hands, leads to a very natural arrangement of the family. Following this, we find that four incisors above and four below unite the four Seals of the Southern Ocean with the Mediterranean Seal. The six northern species, again, have all six incisors above, and four below, their hands being like those of the "Bearded" and "Common" Seals. Lastly, four incisors above and two below separate off those very remarkable forms, the "Bladder Seal" of the north and the mighty "Sea Elephant" of the south, which have the further point in common of a remarkable development of the nasal passages. The Sea Leopard—or Leopards, if there are really two—together with the Crab-eating Seal, which ought most probably to be united in the same genus with them, inhabit the Antarctic Ocean. In the last-named species the molar teeth are remarkably modified.

The fourth Antarctic Seal is that called *Ommatophoca rossi*—Ross's Large-eyed Seal, known only from specimens procured from Sir J. Ross's Antarctic Expedition. The next species we come to is the Monk Seal (*Monachus albiventer*), which inhabits the Mediterranean and the Island of Madeira.

Of the "Hooded Seal," or "Bladder Nose," till a few days ago a fine male specimen was living in the Society's Gardens. The length attained ranges between seven and twelve feet. Though a true seal, it has the power of using the fore-feet to walk on land to a certain degree. The nose is broad and flat, and in the male the upper wall of the nostril is so loose that it can be blown up at will into a hood. The use of this curious appendage is not known. Its habits are migratory. It is found in South Greenland, rarely in Iceland and Norway, never now at Spitzbergen. The nearest ally to this seal is the "Sea Elephant," described by Anson in 1742, from Juan Fernandez. It has been recorded to be thirty feet long. The nostrils of the male are prolonged into the remarkable appendage which has been the origin of its name, "Proboscis Seal," the tubular proboscis being, when inflated, a foot in length.

Round the English coast there are two species of seals that are tolerably common, the Common Seal (*Phoca vitulina*) and the Great Grey Seal (*Phoca gryphus*). The former frequents both sides of the North Atlantic, Spitzbergen, Greenland, and Davis' Straits. The latter species is far rarer in this country. It is not found in Polar waters nor in the Mediterranean Sea, where the former exists. Further north we come to three other seals, the Bearded Seal (*P. barbata*), the Greenland Seal (*P. grœnlandica*), and the Ringed Seal (*P. hispida*); the two latter sometimes appear on our coasts as stragglers.

The lecturer concluded by remarking on the necessity for some international agreement to prevent the destructive effects of the short-sighted policy now adopted in seal-hunting.

(*To be continued.*)

ON LIGHTNING FIGURES

THE letter headed "Struck by Lightning," and signed "D. Pidgeon," contained in NATURE, vol. xi. p. 405, is valuable, and the more so because it is unaccompanied by any theory. Formerly, when ramified marks appeared on the persons of men or animals, they were always referred to some near or distant tree, of which the marks formed "an exact portrait." Thus, in the *Times* of September 10, 1866, is an account of a boy who had taken refuge under a tree during a thunderstorm, having been struck by lightning, and on his body was found "a perfect image of the tree, the fibres, leaves, and branches being represented with photographic accuracy."

In a paper read by me before the British Association at Manchester in 1861, I attempted to show that such ramified figures are not derived from any tree whatever, but represent the fiery hand of the lightning itself. Very instructive tree-like figures may be produced on sheets of crown glass by passing over them the contents of a Leyden jar. For this purpose the plates (those I used were four inches square) should be put into a strong solution of soap, and wiped dry with a duster. If a plate be then held by the corner against the knob of a small charged jar, and, with one knob of the discharging rod resting against the outer coating, the other be brought up to the knob of the jar with the glass between, the spark will pass over the surface of the pane, turn over its edge, and thus arrive at the knob of the rod. Nothing is visible on the plate until it is breathed on, and then the condensed breath settles in the form of minute dew on those parts of the soapy film that have not been burnt off by the electricity, while on the lines that have been burnt off or made chemically clean the moisture condenses in watery lines, bringing out the trunk, branches, and minute spray of the dendritic figure in a very perfect manner. In the discussion that followed the reading of my paper, the president of the section remarked that the figures exhibited would pass for trees all over the world. The discharge sometimes exhibits bifurcations and even trifurcations. The main trunk is evidently a hollow tube, as in the vitrified masses known as fulgurites, where lightning ploughs through a sandy soil. Should the plate be too thick, the main discharge may not pass, in which case the plate represents spray only. Hence I infer that the spray precedes the discharge and acts as a feeler for the line of least resistance. Indeed, it is an old observation of sailors, that before the ship was struck everyone on board felt as if cobwebs were being drawn over his face.

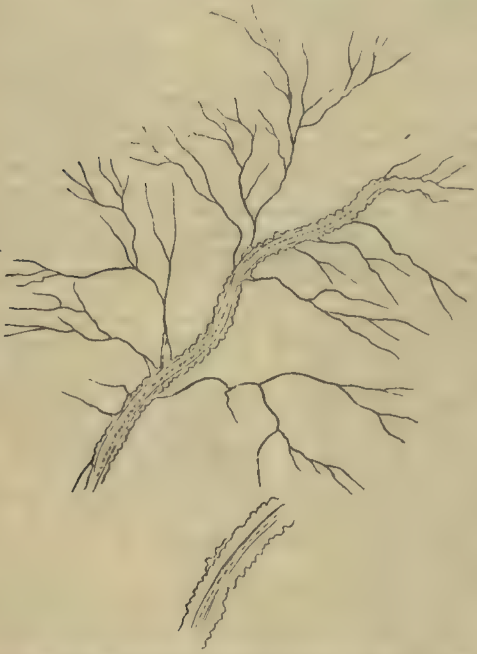


FIG. 1.—Breath Figure of Electric Discharge (also called *Roric Figure*, from *Ros-roris*, "dew.")

The accompanying (Fig. 1) is one of the figures produced as above described, the separate figure being an enlarged portion of the stem or trunk which represents the main discharge. Other examples may be found in the "English Cyclopædia" (Arts and Sciences division), article "Breath Figures," and in the *Edinburgh New Philosophical Journal* for October 1861.

After the reading of my paper I was anxious to see some examples that had been undoubtedly produced by lightning of these ramified figures. I was gratified by the receipt of a letter from Dr. Pooley, of Weston-super-Mare, informing me that he had actually seen a tree struck by lightning, that the inner surfaces of the detached bark contained ramified figures such as I had described, and that he had sent specimens to Dr. Faraday. I accordingly applied for permission to examine them. The figures on the bark had become very faint, but the following engraving (Fig. 2) represents their character.

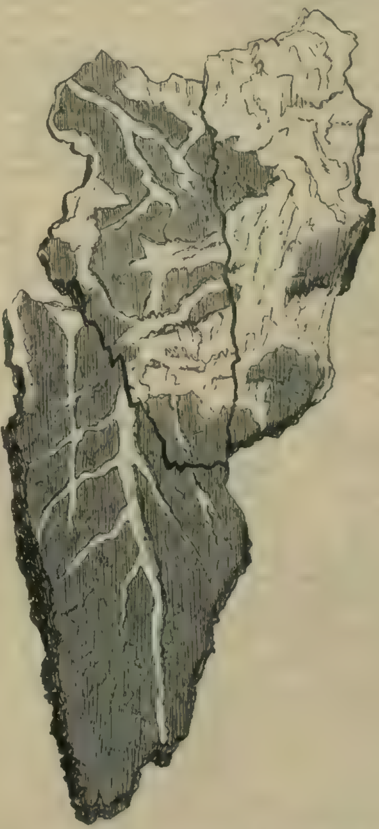


FIG. 2.—Three Portions of the Inner Surface of the Bark.

In the *Lancet* of July 30, 1864, Dr. D. Mackintosh describes a case in which a straw stack was struck by lightning and set on fire, while a man who had sought its shelter was killed, and two boys injured. One of the boys, aged ten, said he felt "dizzy all over;" his legs would not carry him, and he felt pain in the lower part of the abdomen. On taking off his clothes a peculiar sulphurous singed odour was perpectible, and also several irregular but distinct red streaks, of about a finger's breadth, running obliquely downwards and inwards on either side of the chest to a middle line in front of the abdomen, whence they converged; from this point they diverged again till they were lost in the perineum. The streaks were of a brighter red on the more vascular parts of the body; they disappeared in about four days, and the lad recovered.

In the second case, that of a boy aged eleven, "the figures on either hip were so exceedingly alike and so striking, that an observer could not but be impressed with the idea that they were formed in obedience to some prevailing law."

In the third case, that of a man of forty-six, the discharge passed through the head, and seems to have produced instant death.

The phenomena in the case of the two boys agree very well with those described in Mr. Pidgeon's letter.

But there are various other figures produced by lightning sufficiently numerous to have led M. Baudin, in his

"Treatise on Medical Geography," to apply to them the term *Keraunography* (to write with thunder). Mr. Poey, in 1861, published a small volume in which twenty-four illustrative cases are cited. The author starts with the popular notion that the dendritic figures referred to are derived from some near or distant tree, and then proceeds to account for them by means of a photo-electric action in which the surface of the animal is the sensitive plate; the tree, &c., the object; and the lightning the force that impresses it.

But in connection with our subject are other facts, startling, it is true, but recurring from time to time in different parts of the world, and reported by sailors and others, who possess the invaluable art of recording their observations without attempting to explain them. The desire of explaining everything often amounts to a kind of rabies, when the sane course seems to be to wait; for if a reasonable theory is impossible, an unreasonable one is ridiculous. Nevertheless, some observers, if they cannot explain a fact, deny its truth; and yet such facts may exist in nature, and only wait the progress of discovery, when in due time they are gathered in under the sickle of the appointed reaper. Three such facts are the following:—

1. In September 1825, the brig *Il Buon Servo*, anchored in the Bay of Armiro, was struck by lightning, and a sailor who was sitting at the foot of the mizenmast was killed. Marks were found on his back, extending from the neck to the loins, including the impression of a horse-shoe, perfectly distinct, and of the same size as the one that was fixed to the mast.

2. In another case that occurred at Zante, the number 44 in metal was attached to the fixed rigging between the mast and the cot of one of the sailors. The mast was struck and the sailor killed. On his left breast was found the number 44, well formed and perfectly identical with that on the rigging. The sailors agreed that the number did not exist on the body before the man was struck.

3. M. José Maria Dau, of Havannah, states that in 1828, in the province of Candelaria, in the island of Cuba, a young man was struck by lightning, and on his neck was found the image "d'un fer à cheval qui avait été cloué à peu de distance contre une fenêtre."

Unexpected light was thrown upon such cases by Mr. C. F. Varley (Proc. Roy. Soc., Jan. 12, 1871), in following up an accidental observation during the working of a Holtz electrical machine, the poles of which were furnished with brass balls about an inch in diameter. Noticing some specks on the ball of the positive pole, Mr. Varley tried to wipe them off with a silk handkerchief, but in vain. He then examined the negative pole, and discovered a minute speck corresponding to the spots on the positive pole. This pole sometimes exhibits a glow, and if in this state three or four bits of wax, or even a drop or two of water, be placed on the negative pole, corresponding non-luminous spots appear on the positive pole. Hence it is evident that lines of force exist between the two poles, by means of which we may telegraph through the air from the negative to the positive pole. And in explanation of the above cases in which the lightning-burn on the skin is of the same shape as the object from which the discharge proceeded, all that is necessary is that the object struck be + to the horse-shoe, brass number, &c., the discharge being a negative one.

C. TOMLINSON

INAUGURATION OF THE ZOOLOGICAL STATION OF NAPLES

AFTER the first working year a formal inauguration of this new institution took place on April 11. Dr. Dohrn had invited the Italian Minister of Public Instruction, Signor Borghi, and the German Ambassador at Rome, Herr von Kendell, to be present as representatives of the two countries which had most assisted in completing the new establishment, the one granting the locality, whilst the other paid a subvention of 3,000*l.* towards the expenses of the construction. Unfortunately both gentlemen were at the last moment prevented from being present, but sent two letters stating their great sympathy and the sympathy of the two Governments which they represent, for the Zoological Station.

The inauguration solemnity consisted chiefly in an inaugural address read by Dr. Dohrn himself to an audience of distinguished gentlemen, and a short answer given by Signor Paureri, the well-known Professor of Anatomy of the Naples University.

Before giving an abstract of the address, it may be permitted to say a few words about the life and work of the Zoological Station during the first year of its existence.

The following naturalists have made use of its laboratories:—From *England:* Mr. Balfour, Mr. Dew Smith, Mr. Marshall, from Cambridge; Mr. E. Ray Lankester, from Oxford. From *Holland:* Mr. Hubrecht (Leyden), Dr. Hoek (Haag), Prof. Hoffmann (Leyden), Dr. Hoorst (Utrecht), Prof. Van Ankum (Groningen). From *Germany:* Prof. Waldeyer (Strassburg), Prof. Wilh. Müller (Jena), Dr. Korsmann (Heidelberg), Prof. Hesslöhl (Constanz), Prof. Greeff (Marburg), Profs. Kollmann and Ranke (Munich), Dr. Steiner (Halle), Prof. Oscar Schmidt (Strassburg), Prof. Langer Lans (Freiburg), Dr. v. Thering (Göttingen), Dr. Götte and Dr. Lorent (Strassburg), Dr. Vetter (Dresden), Prof. Selenka (Erlangen). From *Austria:* Prof. Claus (Vienna) with two students of the Vienna University. From *Russia:* Prof. Salensky (Kazan), Dr. Rajewsky (Moscow), Dr. Bobretzky (Kiew), Dr. Ulianin (Moskau), Dr. Rosenberg (Dorpat), Cand. Isnoskoff (Kazan). From *Italy:* Dr. Cavanna (Florence), Dr. Fanzago (Padua), Dr. Zingone (Naples).

Some of these naturalists have been working a whole year in the Zoological Station; some have come back a second time; the greater number have only stayed the winter, especially from February till May, a period when the Station is likely to be visited more frequently than at any other.

If one compares the number of naturalists coming to Naples in former years to study Marine Zoology with the number of those who are named above, it is at once obvious how great an effect the Zoological Station has had on the increase. Formerly from three to five zoologists used to come during the year to Naples, often even less, or none. From Easter 1874 till Easter 1875, there were thirty-six naturalists, and during March and April of this year alone there have been working contemporaneously in the Zoological Station eighteen zoologists.

This shows how considerable in a quantitative point of view the increase of scientific work done at Naples has become. It is besides obvious that the arrangements in the Zoological Station—the great Aquarium providing almost natural conditions of life to the animals, the daily supply of fresh material, the facility offered by the library for consulting the literature, and the personal intercourse among so many scientific men,—must have also a favourable influence on the quality of the work, by enabling each of the naturalists to concentrate his energy solely on the scientific difficulties of his pursuit, not having at all to deal with any of the tiresome, very trying, and for a single man often almost insurmountable obstacles of a more practical character which are in the way of these studies.

Besides, one must not forget that the Zoological Station is still in its infancy, and has grown to its present state of working order in the midst of difficulties of every kind and character. Granted a greater experience in the line of its actions, especially a greater knowledge of the sea and its localities, currents, temperatures, and other conditions affecting the life and habitat of the animals; granted, further, an increased income to allow a more liberal endowment of its different parts, viz., library, collection, laboratories, and also an increase in its leading and scientific staff; granted, finally, new donations and subventions like those of the English naturalists and of the German Government, and we may be pretty sure that the Zoological Station at Naples will in future be a quite indispensable and very powerful instrument for scientific research.

At present the following Governments and Universities have entered upon contracts with the Zoological Station for one or two tables:—Prussia, Italy, Russia, Austria, each for two tables; Bavaria, Saxony, Baden, Mecklenburg, Holland, and the Universities of Cambridge and Strassburg, each for one table. Negotiations have been entered upon with Würtemberg and Hesse-Darmstadt. Accommodation for twenty-four naturalists will be ready for next winter, and it is hoped to augment the daily arriving quantity of marine animals for investigation by help of a small steam launch, which will be always out on fishing expeditions, weather permitting.

All this together shows a regularly working institution, which, we believe, deserves the full attention of scientific men as a new element, or, to use an expression applied to it once by Prof. Owen, a new dynamic in science.

The following is an abstract of Dr. Dohrn's inaugural address:—

Dr. Dohrn began by referring to the success which has hitherto attended the Naples establishment, to the Andersonian School of Natural History in America, and to the Zoological Station which the Austrian Government proposes to establish at Trieste. He then proceeded to show what may in time be expected from the institution; in what its duties principally consist.

The original purposes of the undertaking was to facilitate the labours of the zoologists who come to Naples from all parts of Europe to study the marine animals of the Bay. For this purpose it is of course necessary to enter into relations with the fishermen in the Bay, in order to obtain the needed supply of fish; but this method is so far from satisfactory that Dr. Dohrn, as soon as the state of funds permits, is resolved to obtain a small steamer, properly fitted up; with such assistance only can the purposes of the institution be satisfactorily carried out.

Dr. Dohrn then referred to the library of the Station, which he is exceedingly anxious to make as complete as possible, and hopes that authors, publishers, and academies will continue to supply the wants of the Station in this respect. He is especially anxious to obtain systematic works, the want of which has already made itself painfully felt. The institution greatly depends upon its pecuniary resources, and he hopes those who are friendly to its purpose will continue to lend it a helping hand.

The Zoological Station will continue to supply foreign universities, laboratories, museums, and private collections with marine animals, carefully preserved according to the directions of the person who orders them.

Besides thus endeavouring to further the work of others, the Station has important scientific tasks of its own. One of the chief of these is an exact determination of the fauna of the Bay. Not only for its own sake is this task one of the first duties of the Station, but it will be of great assistance in facilitating the work of the Station in other directions. It may be objected that the smallness of the means at the disposal of the Station is inadequate to the fulfilment of all these purposes. While the justice of this objection is admitted, there is at the same time no doubt that a great future is in store for Zoological Stations; for the principle on which they are founded will remain, and give rise to ever new realisations.

The decreasing importance which the study of zoology holds in the medical curriculum can hardly be avoided without inordinately lengthening the time required for such a course, medical science itself has become so subdivided and specialised. Still, those who look upon the medical profession as something more than merely a means of livelihood, will not treat zoology with indifference, but will perceive the important bearing it has on the proper understanding of many medical problems.

The importance of the principles of the Development theory on the progress of medicine are then insisted on. In the case of transmission of a hereditary tendency to certain forms of disease, the application of these principles might be made to serve a most important purpose, if thoroughly understood and carefully carried into practice. "How important must it be to ascertain the conditions of such a transmission, to discover the symptoms which, though in the present state of our knowledge they may escape observation, may in the earliest years show a morbid predisposition, and thus warn us to conduct the whole physical and moral education of the child with reference to the hidden enemy. . . . As soon as these truths have become a part of the intellectual possessions of the people, as soon as physicians and teachers bear them constantly in mind and act in accordance with them, how different will education become! For in this the highest significance of the Darwinian theory consists, that its principles embrace the moral as well as the physical nature of man, and that their critical application may bring about intellectual as well as corporal changes.

"As soon as its high practical value is established and recognised, no doubt can be entertained that the progress of zoology, the chief exponent of these laws, is an essential furtherance to the advance of morals and the reasonable adjustment of human life; and it follows that society—and the highest form of society, the State—are not only entitled, but in duty bound, to afford a free opportunity for zoological investigation, and to support it by all the means in their power."

Zoology is now so advanced and subdivided that at the various universities the professorships of Zoology should be at least doubled; no man is able adequately to teach all branches of it. Moreover, laboratories must be established at the seaside, and still more, stations in various parts of the world.

Dr. Dohrn bespoke the utmost toleration for the Darwinian theory from all classes. He hoped that the fact that he had connected the name of the Station with the development and application of the Darwinian theory would not prevent anyone from lending it his support.

"When the fundamental principles of Darwinism are once thoroughly understood, it becomes clear that it is not nearly as revolutionary as some of its disciples seem to suppose. On the contrary, it is the declared enemy of all revolutions. It takes its stand on concrete reality, and teaches, like Hegel, that the real is the reasonable. It sees in all that exists the necessary result of a long process of development, in which innumerable influences have contributed to render the present world what it is, and not something quite different from it. But it sees in the present world only the *present* world; tomorrow it will be changed. What in to-day is the effect of yesterday, must at the same time be the cause of tomorrow. Thus Darwinism is at once extremely tolerant and the prophet of a different future. If at times this should not appear to be the case, the blame is due, not to the theory, but to its advocates, who often seem not to understand the doctrines they so zealously teach, since they are enraged at an opposition which, if they understood how necessary and inevitable it is, they might with ease gradually but certainly remove."

It was shown that the Development theory is applicable to all forms of existence and to all departments of human life. If the law were carefully applied to history as well as to nature, we might hope to be able to reduce the phenomena of both to one great law of development, by means of which we should be enabled better to understand both the past and the future, and to judge more clearly of the present.

The important bearing which the work at the Naples and similar stations had on the elucidation of this law was then pointed out. "Every fish, every crab, every Medusa is the result of a long process of development, which we have to trace, and the determination of which the Zoological Station is intended to facilitate. That is its purpose; it was for that end that I built it, and for that reason I have asked you to lend your support to my efforts."

THE "VILLE DE CALAIS" BALLOON ASCENT

PARIS, *May* 3.

WE made our ascent yesterday from La Villette gasworks at 1·25 P.M., and landed safely in a field at Creney, a small country place four miles south-east of Troyes, which is about 100 miles south-east from Paris. After having made observations during a little less than six hours, our grapnel was let down at ten minutes past seven. There were three of us in the car—M. Duruof, Mr. Marriott, an English correspondent in Paris, and myself. The maximum altitude reached was about 12,000 feet. The ascent was very gradual, and the above height was reached only at six o'clock. No sensible effect was perceived, although the temperature of the air, which on the ground was about 50° F., was no more than 26° at this altitude. We tried several experiments, with what success it remains to determine on examination of the apparatus. Some of the results, however, I am able to state here.

We had suspended to the net a number of cages containing small birds and guinea-pigs. The current of gas had a decided inclination to flow in a certain direction, and we had not ascended 6,000 feet when one of the birds was found dead by suffocation. It was the only bird exposed to the inhalation of the current of gas, and no other was injured. It was proved by a careful autopsy executed this morning by Dr. Lionville that this bird had perished by intra-osseous hæmorrhage in the cranium. The hæmorrhage had taken place on both sides, and without any lesion appearing to the exterior.

We discovered that not less than four different banks of clouds were being carried over Paris and its vicinity. Before the end of our journey the clouds had considerably diminished in thickness, and the blue sky appeared. I was able to take some thermo-solar observations with a blackened bulb thermometer *in vacuo*.

As the effect on our constitutions of our 12,000 feet trip was very trifling, I am of opinion that the experiment may be scientifically conducted gradually to an immense altitude, independently of previous catastrophes.

W. DE FONVIELLE

NOTES

AS we announced some months ago (Dec. 24, vol. xi. p. 153), Prof. Huxley is to undertake the duties of Prof. Wyville Thomson's chair of Natural History in the University of Edinburgh during the present summer session. Prof. Huxley gave his introductory lecture on Monday afternoon to a large audience. He was accompanied by Principal Sir Alexander Grant, Principal Tulloch, St. Andrews, and the members of the Senatus, and was enthusiastically received. He expressed at the outset a hope that at this time next year Prof. Thomson would be among them again, full of health and vigour, laden with the spoils of the many climes through which he had travelled, and a sort of zoological Ulysses, full of wisdom for their benefit. He then took a general view of his subject, put before the class the considerations which resulted from the careful study of a single animal, the Crocodile; an animal which was worthy of attentive study, as it might be said that a knowledge of its organisation was the key to the understanding of a vast number of extinct reptiles, and the key to the organisation of birds; while it helped them to connect the higher with the lower forms of vertebrate life, and was, in part at any rate, the key to the history of past life upon the globe. There might be asked respecting this animal, as respecting every other living thing—first, what was its structure? second, what did it do? third, where was it found? and fourth, in virtue of what chain of causation had this thing come into being?—this last having only been recently recognised as one of those questions which might legitimately be put. He then proceeded to describe the organisation of the Crocodile—its morphology, physiology, and distribution; and remarked that there were few animals about the palæontological history of which they knew so much, as they could carry back its history through the tertiary and secondary epochs. The answer to the last question constituted Ætiology, or the science of the causes of the phenomena of morphology, physiology, and distribution. Here, as in all cases where they had to deal with causation, they left the region of objective fact and entered that of speculation. With their present imperfect knowledge, the only safe thing they could do in attempting to form even a conception of the cause of this extraordinary complex phenomenon was what a wise historian would do—stick by archæological facts. He pointed out that palæontological facts showed that there had been a succession of forms of that animal to the present day, the oldest being something like the Lizard.

THE Instructions prepared for the use of the officers of the Arctic Expedition in their Scientific work are now nearly complete, and all the courses of instruction, comprising the use of magnetical, astronomical, and meteorological instruments and of spectroscopes, will be concluded next week, many officers from both ships having taken part in them. We believe that the present arrangement as to date of leaving, the 29th instant, may be considered as final. We have already stated that the exploring ships are to be accompanied as far as Disco Island by the *Valorous* for the purpose of enabling them to fill up with stores and coal at the last moment. At the suggestion of the Council of the Royal Society, advantage will be taken of the presence of this ship to make observations in a little explored region, her homeward voyage being employed in carrying out such a physical and biological exploration of the southern part of Baffin's Bay and the North Atlantic between Cape Farewell and the British Isles as may serve to complete the work which is being so successfully prosecuted in other seas by the *Challenger*. Mr. J. Gwyn Jeffreys, the coadjutor of Dr. Carpenter and Prof. Wyville Thomson in the *Porcupine* expeditions, which first demonstrated the feasibility and scientific importance of this kind of exploration, has volunteered for the service, and he will take with him as his assistant Mr. P. Herbert Carpenter, who did good work when accompanying his father in the *Porcupine*, and who will especially take charge of the physical inquiries.

M. CORNU'S lecture on the velocity of Light at the Royal Institution to-morrow evening is looked forward to with great interest. We believe he intends to speak in French, though his knowledge of English renders him quite competent to make use of that language if he chose. An account of the results attained by M. Cornu will be found in NATURE, vol. xi. p. 274.

HOFRATH HEINRICH SCHWABE died at Dessau on April 11; he reached a patriarchal age, having been born on Oct. 25, 1789, at Dessau. He retained his faculties to the last, although he had been compelled for many years to relinquish his favourite astronomical studies, which in 1857 had won for him the Royal Astronomical Society's Gold Medal.

CHEMISTRY in Germany and in Austria has to deplore two severe losses. On the 15th of April died Prof. von Schrötter, Master of the Mint in Vienna, and known best through his discovery of amorphous phosphorus and his determination of the atomic weight of phosphorus; he died at the age of seventy-three years. A few days later Prof. Carius died at Marburg after a protracted illness. Although only forty-six years old, he leaves behind him the record of very numerous researches, of which those on the sulpho compounds, corresponding to glycerine and its derivatives, on the oxysulphides of phosphorus, on the action of hypochlorous acid on hydrocarbons, and on the analyses of organic chlorides, iodides, bromides, sulphides, and phosphides are best known.

THE *Times* of the 30th ult. contains a letter from its correspondent with the *Challenger*, dated "Zamboango, Jan. 31." The *Challenger* left Hong Kong on Jan. 6, and proceeded to the middle of the China Sea, where a series of temperature soundings was taken, the temperature at the bottom, 1,200 fathoms, being found to be 36° Fahr. This temperature is accounted for by Capt. Chimmo's statement, that the China Sea is cut off by a barrier, which rises to a height of between 800 and 900 fathoms below the surface of the water, from communication with the Antarctic Ocean. Passing along the west coast of Luzon, the *Challenger* entered a little enclosed sea extending from the north point of the island of Tablas to the strait between the north-east angle of Panay and the south-west point of Masbate. Here another series of interesting temperature soundings was taken, the temperature at bottom, 700 fathoms, being 51·7°. The temperatures generally in this Panay Sea were to a certain extent intermediate between those in the China Sea on the one side and the Zebu Sea on the other, leaving it uncertain whether the cleft in the barrier to the depth of 150 fathoms is between Tablas and Panay or between Romplon and Sabuyan. After visiting Zebu, near which some fine specimens of the beautiful sponge the "Venus' Flower-basket" (*Euplectella*) were trawled, the ship made for the small island of Comiguin, between Mindanao and Bohol, to inspect the active volcano therein. This volcano "was born on May 1, 1871," and now forms an irregular cone of 1,950 feet in height. From Comiguin the *Challenger* proceeded along the west coast of Mindanao to Zamboango, where a party of sportsmen were sent to camp out in the forest within riding distance of the ship. On leaving Zamboango, a run of about 2,000 miles was to be made nearly parallel with the equator, and only a few degrees to the north of Greenwich Island. Thence the expedition was to make one of the most important sections, through the Caroline and Ladrone Islands to Japan, where it was expected to arrive about the second week of April.

THE enterprise of the Scottish Meteorological Society we have had frequent occasion to refer to, and the practical as well as scientific value of the work it undertakes does it the greatest credit, especially when its narrow means is taken into consideration. One of its latest publications is a diagram by Mr. G. Thomson, Fishery Officer, Lybster, Caithness, showing for the months of July, August, and September, 1874, the catch and quality of the herrings, and the varying positions of the herring-ground in the district of Lybster, as also the meteorology of the district. The diagram, which has been revised by the secretary, Mr. Buchan, is ingeniously constructed and quite intelligible. There are two series of conjoined curves and tables, the first showing all details belonging to the meteorology of each day, and the second showing the catch and quality of fish. Underneath are a sketch of the coast and indications of the different fishing grounds occupied. The diagram, we believe, is intended for distribution among the various district fishery officers in Scotland, with the view of inducing some of them to prepare similar diagrams for 1875 for their own districts. With these, and the observations from twenty sea-thermometers which were presented by the Marquis of Tweeddale, as also of the weather during the coming season, results may be hoped for that will throw some light on the important question of the varying localisation of the fishings.

THE Committee of the forthcoming Geographical Congress at Paris have finished the distribution of the space allotted to the various countries in the *Pavillon de Flore* for exhibition; the geographical order has been adopted in locating the several nations. Russia, being the most northern, has been placed first; but magnificent rooms have been allotted to British exhibitors on the ground-floor. Everything has been done to ensure a splendid display of English science and industry, and great things are expected from the nation which, without any boasting, may be said to have done as much as many others put together to open the world to civilisation. The presidents of the English Committee are the Earl of Derby, Sir H. Rawlinson, and Sir Bartle Frere. Great interest is felt by the Society and the Committee in the Polar Expedition, and models of the two ships, of sledges, boats, &c., would be most particularly popular and very thankfully received.

THE Council of the Senate of Cambridge University upon the Grace which proposed to constitute a Syndicate for the purpose of considering what representations should be made to the Government as to the pecuniary and other relations subsisting between the University and the Colleges, are of opinion that it should be withdrawn; they think, however, that it is advisable to obtain the general opinion of the University on the following points:—1. What additional teachers or appliances for teaching are required in the different departments of University study. 2. How these teachers and appliances may be best supplied, whether by the individual Colleges or by the University, or partly by the one and partly by the other. 3. Whether by any improved organisation the systems of professorial and collegiate teaching may be made more efficient and be brought into closer relations with each other. 4. How the teaching in the University may be organised so as to give the greatest encouragement to the advancement of the several branches of learning. They therefore recommend that a Syndicate be appointed to consider these subjects. The Vice-Chancellor invites discussion of this report on Saturday next, at 2 P.M., in the Arts School.

A SYNDICATE has been appointed to consider what steps (if any) should be taken for establishing a Professorship of Mechanism and Engineering in the University of Cambridge.

The late Prof. Willis, by his will, offered to Cambridge University, for 1,200*l.*, the collections of models, instruments, and tools used by him as Jacksonian Professor. A Syndicate has been appointed to consider the expediency of purchasing the whole or part of the collections.

FOR some time past negotiations have been in progress between Prof. Charles F. Hartt, of Cornell University, and the Government of Brazil, in regard to a complete geological survey of that empire. It is now stated that the preliminaries have been completed, and that Prof. Hartt has been appointed director of the survey. His preparations for this work are ample, as he has made no less than four successive visits to Brazil with reference to the study of its general geology and ethnology. His salary is said to have been fixed at $10,000 a year. It is also announced that Prof. Caldwell, another member of the faculty of Cornell University, has been appointed to take charge of the agricultural branch of the survey.

IN reference to a note in *Dingler's Polytech. Journal*, mentioned in NATURE, vol. xi. p. 456, there is a second paper in the valuable serial (2nd January part) on the part played by carbonic oxide gas in smoking. This treatise is by Dr. Vohl, and refutes Dr. Krause's opinion. He says: "It is evident from Dr. Krause's account that he is unaware of the experiments made by Dr. H. Eulenberg and myself as far back as 1871, which proved the presence of carbonic oxide in tobacco smoke. I cannot, however, agree with the idea that the physiological effects of smoking are to be in part or wholly attributed to this gas, as it varies greatly in the quantity in which it is present in smoke. This quantity is never considerable, and the effects in question must rather be ascribed to the volatile organic bases, which form while tobacco is burning. Dr. Krause owns himself that his analytical results are not exact, on account of the method he used in obtaining them; these results cannot therefore give any idea as to the quantity of carbonic oxide generally present in tobacco smoke, as neither the temperature nor the barometrical pressure was noted, nor was any account taken of oxygen and marsh gas."

The Government has taken up the question of the protection of seals in the Greenland seal fishery; and a Bill has been introduced into Parliament by the Board of Trade, authorising the issue of an Order in Council prohibiting the capture or destruction of any kind of seal between such dates as may be specified in such Order, in any part of the area included between the parallels of 67° and 75° N., and the meridians of 5° E. and 17° W. Such Order is to be made whenever it shall appear that the other States whose subjects and vessels are engaged in the seal fishery shall make similar regulations. The great destruction of seals which has taken place of late years has seriously interfered with the success of the important industry. This year many of the vessels have returned "clean."

M. Wallon, the French Minister for Public Instruction, has visited the Lille Academy and Colleges, and was received with a great display of enthusiasm. He is said to contemplate many improvements in educational establishments in large provincial cities; these are to be tried first in the city where he was born, and which he represents in the National Assembly.

The Council of the lately-established United Services College, Westward Ho, have resolved to introduce Natural Science into the regular school-work; in fact, to place it on an equal footing with Languages and Mathematics as a means of mental training. They have appointed as master Mr. Herbert Green, F.C.S., M.A., of Queen's College, Oxford, who has had some years' experience at Victoria College, Jersey. A laboratory will be at once fitted up under his supervision, and class-rooms will be added as required.

With regard to the statement quoted from Dr. Cleland's book on Animal Physiology (Nature, vol. xi. p. 504), "that the presence of chlorophyll is as necessary for the production of organic matter in organisms as the presence of protoplasm is necessary for growth," a correspondent points out that fungi seem to be an exception to the rule. He has never seen it stated that Torula, for instance, contains chlorophyll, nor has he ever himself seen chlorophyll in Torula. It is generally agreed, he believes, that fungi do not contain chlorophyll or starch.

Dr. John Croumbie Brown, F.L.S., author of a work on the Hydrology of South Africa, is preparing for the press a work which he intends to call "Reboisement en France." It will consist of records of the replanting of the Alps, the Cevennes, and the Pyrenees with trees, herbage, and bush, with a view to arresting and preventing the destructive consequences and effects of torrents, and will embody a *résumé* of Alexandre Surell's "Étude sur les Torrents des Hautes Alpes," with copious extracts.

The Annual Meeting of the Royal Institution was held on Saturday last. Sixty-four new members were elected in 1874. The following gentlemen were unanimously elected as officers for the ensuing year:—President, the Duke of Northumberland, D.C.L.; Treasurer, George Busk, F.R.C.S., F.R.S.; Secretary, William Spottiswoode, M.A., LL.D., Treas. R.S. The Vice-presidents for the year are the Duke of Devonshire, K.G., Dr. Pole, F.R.S., and Dr. C. W. Siemens, F.R.S.

The Iron and Steel Institute commenced its meetings yesterday; we hope to be able next week to give some account of the work done.

We believe that Mr. Disraeli has promised to receive a deputation on the subject of the India Museum after the Whitsuntide holidays.

Steps are being taken to obtain the assent of the Emperor to a proposal for holding an Imperial German Industrial Exhibition in Berlin in 1878.

Mr. Stanford is about to publish Part I. of "Vestiges of the Molten Globe," by Mr. W. L. Green, Minister of Foreign Affairs to the King of the Sandwich Islands. The work will be concluded in three parts, and will, we believe, contain some curious observations as to the formation of minerals, Mr. Green having had many opportunities of watching the process during his twenty-five years' residence beside the Hawaiian volcanoes.

Mr. Edward B. Aveling, B.Sc. Lond., has been appointed Lecturer on Comparative Anatomy at the London Hospital Medical College.

Mr. J. Rand Capron has reprinted from the April number of the *Philosophical Magazine* his paper "On the Comparison of some Tubes and other spectra with the Spectrum of the Aurora."

Vine culture in New South Wales is progressing very rapidly, the number of acres occupied for this purpose being 3,183 in 1873, against 2,568 acres in 1872, and the produce 575,985 gallons against 451,450 gallons. These figures relate only to the growth of grapes for wine-producing purposes, but a considerable area is devoted to the cultivation of the vine for other objects. In Western Australia also, where the soil and climate are eminently favourable to the growth of the grape, this pursuit is becoming more general.

Much information on the functions, the form, and the habits of the Octopus may be obtained from a small work by Mr. C. Mitchell, recently published by Messrs. Dean and Son. The structure and economy of the animal are, in it, explained in a particularly lucid and interesting manner, which will lead those who have the opportunity of seeing the Octopus in an aquarium for the first time, to form a far better idea of the somewhat shapeless mass presented to their view, than any amount of time spent in simply inspecting it at a distance. Some anatomical illustrations which are added will also be found very useful to any one who has the opportunity of obtaining specimens for dissection.

The additions to the Zoological Society's Gardens during the past week include two Pig-tailed Monkeys (*Macacus nemestrinus*) from Java, presented by Mr. A. B. Gordon and Miss H. E. Humphreys; a Patagonian Conure (*Conurus patagonus*) from La Plata, presented by Mrs. Cabry; a Ground Hornbill (*Buceros abyssinicus*) from West Africa, a Concave-casqued Hornbill (*Buceros bicornis*) from India, received in exchange; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, purchased; two White-fronted Lemurs (*Lemur albifrons*), a Hairy Armadillo (*Dasypus villosus*), and four Upland Geese (*Chloëphaga magellanica*), born in the Gardens.

METEOROLOGY, ETC., IN MAURITIUS

THE following letter from Mr. C. Meldrum, dated "Observatory, Mauritius, April 2," to a friend in England, gives some interesting data tending to prove a connection between solar activity and the state of the weather. With his new instruments we may hope soon to have some most important results.

"Since December last the colony has been suffering from drought, and there is very little appearance of a favourable change. February has been the driest month since systematic observation commenced in 1852, and the rainfall for January and March has been far below average. If the present state of things continue long, the island will be hard up for water.

"Coincident with this drought there has been, as usual on such occasions, a great falling off in the number and violence of cyclones in the Indian Ocean. We copy here the log-books of all vessels arriving in port from India, Australia, the Cape, England, &c., so that no great storm can take place over the greater part of the ocean without our getting more or less information about it. Well, the hurricane season is nearly over, and we have heard of only two storms, one on the 24th of January away to the northward of us, and one on the 7th of March, away to the eastward of us, and neither of them seems to have been extensive or very violent, only two vessels having been involved in each. The season thus bears a remarkable contrast to the corresponding periods for 1871, '72, and '73, and furnishes another instance of the now oft-observed fact that when Mauritius suffers from drought the Indian Ocean is almost free from hurricanes. The neighbouring island of Réunion has fared as badly as Mauritius, and the log-books furnish evidence that the drought has prevailed over a wide area.

"The S.E. trade-wind has been blowing from S.E. to E. and E.N.E. almost without interruption during the last three months, and the barometer been unusually high and steady for the season, thus showing that from some cause or other the belt of calms and variables between the S.E. trade and the N.W. monsoon has not advanced so far to the south as it did in the years 1871–74.

"It is only now that I am enabled to keep a continuous record of the sun-spots, the photo-heliograph having been put up a fortnight ago, and being at work only for a week; but from observations made directly, as often as possible, it would appear that there has been a great falling off in the number and magnitude of the spots. If this is the case, then we have, as on many other occasions, a decrease of spots, a decrease of cyclones, and a decrease of rain all at or about the same time.

"Our latest telegraphic news, *viâ* India, states that severe cold prevailed throughout Europe. It would be very interesting to know the conditions of weather for the whole habitable globe during the last three months. Comparative meteorology—including the sun's—can alone throw light on the nature of the relations subsisting between weather changes and variations of solar activity.

"Although the sun-spots decreased considerably in January and February, yet one or two pretty large ones appeared towards the end of February, and on the 27th of that month, between 1 and 7 P.M. we had (for this latitude) a remarkable magnetic storm. I fancy next mail will bring us news of auroras and magnetic storms having been observed in different parts of the world at that time. We had no aurora here, but on the 25th, 26th, 27th, and 28th there appeared, shortly after sunset, long beams of light radiating from a point near the horizon at E. by N. (nearly opposite the sun). This of course is easily explained without an aurora or any fitful outburst on the sun, but I have noticed that these radiating beams, which are sometimes very gorgeous, and occasionally radiate from points near the poles, are much more frequent in some years than others—which may arise from different states of the vapour and clouds. Dr. Lyall, who took a series of observations in Madagascar about forty-five years ago, makes mention of them, and describes them under the name of Aurora.

"We have all the instruments at work now, except the thermograph, which has not arrived. I have been so much occupied with the putting up of the instruments and removing into the new Observatory, that I have had very little time for anything else. I wished to send to the Royal Society some papers, but I could not manage to get sufficient leisure to prepare them. In a short time we shall be in train, and I hope to resume the subject of periodicities, &c."

SCIENTIFIC SERIALS

THE current number of the *Quarterly Journal of Microscopical Science* commences with an account by Mr. Wm. Archer of a new freshwater sarcodic organism, named by the author *Chlamydomyxa labyrinthuloides*, which is illustrated by a superb folio-sized coloured plate, as well as an octavo one. The species is shown to be closely allied to *Labyrinthula* of Cienkowski. The matrix is enclosed in a multilaminate cellulose envelope, which at times appears to burst and give exit to protoplasmic contents, which emerge in an arborescent manner with hyaline prolongations, along which small fusiform protoplasmic masses travel.—Rev. M. J. Berkeley gives a short account of the Thread Blight of Tea, in which he describes the fungus producing it, although he is unable to name it because he has not had an opportunity of examining the fructification.—Mr. P. Kidd draws attention to the occurrence of spontaneous movement in the nucleoli of the epithelium of the frog's mouth.—This paper is followed by an excellent and illustrated account of the structure of the Pacinian corpuscles, considered with reference to the homologies of the several parts composing them, by Mr. Edward Schäfer, in which it is shown—assuming an ordinary nerve fibre to consist of the axis cylinder in the middle, surrounded by, first, the medullary sheath, or white substance; secondly, a delicate layer of protoplasm containing nuclei; thirdly, the primitive sheath (of Schwann); and lastly, the numerous laminæ of the neurilemma, which, however, encloses a layer of finely filamentous connective tissue—that the coats of the Pacinian are the layers of the neurilemma; that the sheath of Schwann surrounds the core, this latter being an expansion of the protoplasmic substance; that the medullary sheath, if not retained as such, disappears, and that the axis-cylinder becomes the central fibre.—Mr. A. W. Bennett gives an account of modern researches into the nature of yeast, specially noticing those of Reess and Cienkowski.—Prof. Lankester has a paper of special theoretical importance, on the Invaginate Planula, or Diplobastic Phase of *Paludina vivipara*; in which, after proposing the name "blastopore" for the orifice of invagination of those Planulæ which exhibit it, he proposes a a classification of Planulæ, which helps to simplify this intricate part of embryonic history. He divides Planulæ into two groups: *Delaminate* Planulæ, in which there is no invagination, but a splitting of the blastosphere to form the endo- and ecto-derm; and *Invaginate* Planulæ, which may be *embolic*, or have no food-yelk; or *epibolic*, possessing a "residual yelk." The Hydrozoa and Calcareous Sponges have delaminate planulæ; Amphioxus, Ascidians, many Mollusca, Sagitta, Echinodermata, and many Vermes have embolic invaginate planulæ; whilst in the third group are included many Mollusca, many Vertebrata, the Ctenophora, certain Vermes, and certain Arthropods.—Mr. H. C. Sorby describes the absorption spectrum of *Bonellia viridis*, and draws attention to a most striking point, namely, that there seems to be a constant ratio between the wave-lengths of the different bands in these spectra.—The number contains its usual excellent quarterly chronicle, notes, &c.

THE *Journal of the Chemical Society* (March 1875) contains the following papers, besides a large number of abstracts from other serials, already noticed in NATURE:—The formulæ of the alums, by S. Lupton. The author briefly states the formulæ given to the alums before they were finally designated as $A' B''' 2SO_4 . 12H_2O$ (where A stands for an alkali metal and B for a metal of the iron group). At present some chemists use this formula, while others double it into $A_2' B_2''' 4SO_4 . 24H_2O$. The cause of this variety of usage rests in the uncertainty attachiug to the atomicity of alumium; this metal appears as a tetrad when combined with chlorine, bromine and iodine, but as a triad in its methyl and ethyl compounds. The author tried to obtain certain bodies similar to the alums in constitution, but differing in the number of molecules of water which they contain; the latter have often served to establish the formula of salts. Experiments were made with iron and ammonium alum, aluminium and potassium alum, and alumium and ammonium alum; these experiments are described, and the author arrives at the conclusion that the doubled formula as above is the correct one, as it seems that upon dehydration the residue $R_2' R_2^{iv} 4SO_4$ remains unaffected, and exists therefore in the ordinary alums in combination with 24 molecules of water.—On the colour of cupric chloride, by Walter Noel Hartley. This salt is almost invariably described as being of a green colour, but the author has found that the salt is only green as long as there is a trace of moisture about it; as soon as the salt is quite dry its crystals are transparent, brilliant, and of a beautiful pale blue tint. A strong solution of the salt is deep green, a dilute solution blue. When the crystals are moist, they may be considered wetted with the dark green solution, and so their true colour is masked.—On the purification and boiling point of methyl-hexyl carbinol, by E. Neison.—This is followed by a note on the same subject from the pen of Prof. C. Schorlemmer. The two gentlemen agree pretty well with regard to the boiling point, which Mr. Neison finds to be at 181°–182°.C., and Prof. Schorlemmer at 179°·5; the difference may probably rest upon the difference of thermometers.—The last paper is on the oxidation of the essential oils, by Chas. T. Kingzett.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Feb. 1.—Dr. Julius Ucke, of Samara, contributes an abstract of his work, undertaken chiefly from a medical point of view, on the quantitative proportions of atmospheric oxygen in different climates, in relation to temperature, moisture, and density of air. The public have chosen certain localities as health-resorts long before science pointed them out as eligible, and although we cannot doubt that oxygen is a great healing power in these, the part it really plays remains to be determined by physiologists and pathologists. The present work merely opens the way to inquiry, and does not claim to go beyond the evidence of statistics. Samara is a health-resort remarkable for the rarity of diseases of respiration, but its climate is windy and not mild, and the changes of temperature are great, both daily and seasonal. The conditions of temperature, moisture, pressure, and wind, do not account for its healthiness. Two factors remain: oxygen and ozone. Oxygen only concerns us at present. In order to find the relative quantity of oxygen at any place, thermometric, barometric, and hygrometric data are indispensable. Thirteen European and three Indian towns and one American station were chosen. Data for Nice, Algiers, and Madeira were wanting. Bearing in mind the hygienic object of his task, Dr. Ucke takes as a measure of the quantities of oxygen the number of inspirations of a grown man in the course of a month of 30·42 days. In the absence of a normal standard, the mean of the results for the seventeen stations is used for comparison. He finds that in the whole year most oxygen is inspired at Samara, least at Seringapatam; that, taking all stations, the quantities are largest in winter, least in summer, except at Seringapatam, where spring gives the lowest figure. Also, that generally the quantities decrease from E. to W. These differences of course depend on the three factors, temperature, density, and moisture. The first two have by far the most considerable effect. The article is illustrated by various tables.

THE *American Journal of Science and Arts*, March.—The principal papers in this number are: On some phenomena of binocular vision, by Prof. J. Le Conte. The article has reference to the direction of the optic axes in sleep. Arguing from "double sight" in drowsiness, Prof. Le Conti concludes that the axes diverge.—The gigantic cephalopods of the North Atlantic, by A. E. Verrill. This is a continuation of a former article in which he records the dimensions of specimens captured within the last few years.—The trap rocks of the Connecticut Valley, by G. W. Hawes. This contains many analyses of dolerites and diabase.—On the comparison of certain theories of solar structure with observation, by Mr. S. P. Langley. (See following article.)—Notes on Costa Rica Geology, by W. M. Gabb. The area described—the district of Talamanca, consists of granite rocks on which rest beds of Miocene age, the granite being pushed up after the deposition of the Miocene.—Under the head of Scientific Intelligence is a description of a new order of Eocene Mammals, *Tillodontia*, by Prof. O. C. Marsh.—Report of progress of Geological Survey of Pennsylvania for 1874.—Notes on the transit of Venus.

Memorie della Societa degli Spettroscopisti Italiani, January 1875.—Mr. S. P. Langley, director of the Alleghany Observatory, contributes a paper on the comparison of certain theories of the structure of sun-spots with observation. He alludes to the so-called "crystalline" forms seen at times in the umbræ of spots, and to their lending confirmation to the views of those who regard the photosphere as a luminous covering of incandescent fluid, and the spots cooling matter in it. The author says that they are at first sight so confirmatory of this view that it was only after long study he had been led to think them assimilable to certain cloud forms in our atmosphere. A beautifully executed steel engraving accompanies the paper, showing the forms alluded to over the umbra of a spot; and they certainly put one in mind of certain forms of cirrus cloud. All the filaments of the penumbra are directed generally towards the centre of the spot; but while all are more or less curved, there is no common direction of curvature. Mr. Langley also remarks that the ends of the filaments are generally the brightest parts, and that it is difficult to resist the impression that they turn upwards at the extremities and appear as though lifting their points through some obscuring medium. One of the crystalline forms appears in great beauty on the spot. It is about 20″ long, and 10″ wide, and has the appearance of a plume or of finely carded wool: and the author asks if we are prepared to admit the existence of a body analogous to a crystal covering ten times the area of Europe. He also refers to sudden and abrupt changes in the direction of the filaments, apparently being due to the passage of one cloud stratum over another, and he remarks this disposition elsewhere in the spot giving a terraced appearance. He says: "It seems difficult to reconcile the bright, sharply-defined inner edge and the regular structure discerned in the umbra, with another view in which this umbra is a sort of stagnant pool formed by cold vapours or clouds which have settled there after depressing the general surface by their weight until the penumbral slope is determined;" and "The theory which regards cyclonic or vertical action as a prominent agent in determining the forms we have studied appears to be in closer accordance with observation than the former."—Father Secchi, in a note on the foregoing paper, remarks that at the edge of the sun, where the spot in question disappeared, there was seen an active prominence, and his further remarks are to be continued in the next number.—P. Tacchini contributes a paper on the condition of Italian and other observatories, giving the staff at each and their salaries. We extract the total payments to the staff and for instruments at the following Observatories:—

	Lire.		Lire.
Paris	54,000	Rome	4,920
Greenwich	75,000	Padua	6,200
Pulkowa	220,000	Modena	4,940
Palermo	7,800	Turin	4,700
Naples	13,248	Bologna	4,500
Florence	6,700	Parma	1,300
Milan	14,802		

SOCIETIES AND ACADEMIES

LONDON

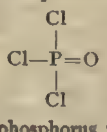
Royal Society, April 15.—"Researches upon the Specific Volumes of Liquids," by T. E. Thorpe. Communicated by Prof. Williamson, For. Sec. R.S.

I. *On the Atomic Value of Phosphorus.*

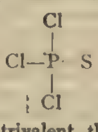
Hermann Kopp has shown that, as a rule, the specific volume of an element is invariable when in combination. Exceptions to the law occur, however, in the cases of oxygen and sulphur, each of which bodies has two specific volumes dependent upon the manner in which they are held in union. When contained "within the radicle," as in acetyl, C_2H_3O, oxygen has the value 12·2, but when existing "within the radicle," as in alcohol, it has the smaller value, 7·8. Sulphur, when "within the radicle," has the specific volume 28·6; when "without the radicle," it has the specific volume 22·6.

The cause of these variations may be thus stated in the language of modern theory:—When dyad sulphur and oxygen are united to an element by both their affinities, their specific volumes becomes respectively 28·6 and 12·2; when they are attached by only one combining unit, their specific volumes are 22·6 and 7·8.

Phosphorus is regarded by certain chemists as invariably a triad; others maintain that it is sometimes a triad, at other times a pentad. In the trichloride it is a triad, in the oxychloride and thiochloride it is a pentad. According to this view the two latter compounds possess the following constitution:—

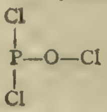


$$\begin{array}{c} Cl \\ | \\ Cl{-}P{=}O \\ | \\ Cl \end{array}$$

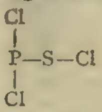


$$\begin{array}{c} Cl \\ | \\ Cl{-}P\quad S \\ | \\ Cl \end{array}$$

If, however, phosphorus is invariably trivalent, the oxychloride and thiochloride must possess the following formulæ :—



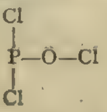
$$\begin{array}{l}\mathrm{Cl}\\ |\\ \mathrm{P—O—Cl}\\ |\\ \mathrm{Cl}\end{array}$$



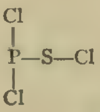
$$\begin{array}{l}\mathrm{Cl}\\ |\\ \mathrm{P—S—Cl}\\ |\\ \mathrm{Cl}\end{array}$$

It is possible to decide between the two modes of representing the constitution of these compounds, if it be granted that the variation in the specific volume of oxygen and sulphur is due to the manner in which these elements are held in union. For if the phosphorus in the oxychloride and thiochloride be quinquivalent, the oxygen and sulphur must possess the greater of the two values, since both their combining units are united to the phosphorus; if, on the other hand, phosphorus be trivalent, the oxygen and sulphur must possess the smaller of the two values.

The author has determined the specific gravity, boiling-point, and rate of expansion of PCl_3, $POCl_3$, and $PSCl_3$, in order to ascertain the specific volume of the oxygen and sulphur in the two latter compounds, and consequently the chemical value of the phosphorus; and he finds that the specific volumes of the oxygen and sulphur are almost identical with the values given by Kopp for these elements when "without the radicle." It would therefore appear that the oxychloride and thiochloride must possess the constitution—



$$\begin{array}{l}\mathrm{Cl}\\ |\\ \mathrm{P—O—Cl}\\ |\\ \mathrm{Cl}\end{array}$$



$$\begin{array}{l}\mathrm{Cl}\\ |\\ \mathrm{P—S—Cl}\\ |\\ \mathrm{Cl}\end{array}$$

and that the phosphorus in these bodies is to be regarded as a triad.

The author concludes by discussing Buff's hypothesis that the specific volume of an element varies with its chemical value; and he shows that in the case of phosphorus there are no reasons for the belief that this element has a variable specific volume.

Geological Society, April 14.—Mr. John Evans, V.P.R.S., president, in the chair.—Descriptions of new corals from the Carboniferous Limestone of Scotland, by Mr. James Thomson. In this paper the author described some forms of corals from the carboniferous limestone of Scotland, which he regards as new species, and as belonging to three new genera allied to *Clisiophyllum.* In the group which he names *Rhodophyllum* the calice is circular and shallow, the epitheca thin and smooth, the septa thin and numerous, and the columellar boss dome-shaped, slightly raised above the inner margin of the primary septa, and clasped by subconvolute ridges. The species referred to this genus are *Rhodophyllum Craigianum*, *R. Slimonianum*, *R. Phillipsianum*, *R. Argylianum*, *R. reticulatum*, and *R. ellipticum*. *Aspidiophyllum* has the calice generally circular, shallow; the septa forming thin laminæ for about half their length from within, when they become flexuous, and the columellar boss prominent and helmet-shaped. The species are named *A. Koninckianum*, *A. Huxleyanum*, *A. cruciforme*, *A. elegans*, *A. Hennedii*, *A. Danai*, *A. dendrophyllum*, *A. ellipticum*, *A. Pagei*, *A. scoticum*, and *A. laxum*. The third genus, *Kurnatiophyllum*, is most nearly allied to *Rhodophyllum*, but has the columellar space slightly raised above the inner margin of the primary septa, and crowned by bending or wavy lamellæ, some of which pass over the central space in sinuous folds. The species are described under the names of *R. concentricum*, *clavatum*, *Tyleranum*, *intermedium*, *ellipticum*, *Ramsayanum*, *Youngianum*, *Harknessianum*, *lamellifolium*, *bipartitum*, *octolamellosum*, *Haimianum*, *Edwardsianum*, and *Davidsonianum*. In a specimen of *Aspidiophyllum Huxleyanum* the author noticed in the open interseptal space a small tube, four lines long, around the inner margin of which there was a group of oval bodies, which, from their close proximity to the inner margin of the primary septa and their form, he is inclined to think may be ova.—On the probable existence of a considerable fault in the lias near Rugby, and of a new outlier of the oolite, by Mr. J. M. Wilson. The author called attention to what appeared to him to be a great fault in the Lower Lias at the village of Low Morton, near Rugby, where a sandpit is worked against the face of a steep hill to a depth of nearly fifty feet. The sand in the valley, as proved by wells and borings, is of great depth. Above the sand-pit is a clay-pit, and the author stated that the clay is bounded towards the sand by a highly inclined face of clay, against which the sand is thrown. This face of clay can be clearly traced for a distance of more than half a mile, running in a south-easterly and north-westerly direction. If continued to the south-east, it would pass close by Kilsby Tunnel, the difficulties met with in the construction of which may have been due in part to a continuation of the fault; whilst if continued to the north-west it would coincide generally with the valley of the Clifton Brook, the bed of which is also occupied by a great depth of sand. The line of fault thus passes between Rugby and Brownsover, and the author suggests that it is the cause of the presence on the summit of the Brownsover plateau of an extensive oolitic mass of Stonesfield-slate character. The line of fault continued further would connect with the Atherstone and Nuneaton fault, and agree with this in having its downthrow on the north-east side.—On a Labyrinthodont from the Coal-measures, by Mr. J. M. Wilson. The fossil referred to in this paper was from the Leinster Coal-measures, and was regarded as probably belonging to the genus *Keraterpeton* of Prof. Huxley, although the outer posterior angles of the skull do not appear to have been prolonged into cornua.—On *Cruziana semiplicata*, by Mr. J. L. Tupper; communicated by Mr. J. M. Wilson. In this paper the author gave a detailed description of a slab of unknown origin, but said to have been obtained from a workman at Bangor, containing several specimens of the fossil described by Salter under the name of *Cruziana semiplicata*. From his examination of the specimen the author seemed inclined to ascribe to *Cruziana* an animal origin, and to regard it rather as fossilised animal structure than as a cast of the track left by the feet of some animal passing over the surface of the sand.

Geologists' Association, April 2.—Mr. Wm. Carruthers, F.R.S., president, in the chair.—Remarks upon geological boundary lines, by Horace B. Woodward, F.G.S. The author believes a tendency exists to overlook the broad classification of lithological characters, and to adopt lines of a palæontological nature. The identity of organic remains is no absolute proof of contemporaneity. In identifying the age of a formation the test of superposition, as a rule, is decisive; and the main facts of palæontology must first be worked out from the stratigraphical succession of the rocks. Still the value of palæontology cannot be disputed, and if we cannot identify formations far separated as synchronous when the fossils are similar, we may parallel successive faunas. Our formations, when looked at in the large way, must be taken to represent deposits of essentially similar character, and characterised by a particular assemblage of fossils. The more we learn of the history of our own strata and those of foreign countries, the less evidence do we see of breaks in the conformity of succession.—Notes on the probable depth of the Gault sea; or, an endeavour to ascertain the relative depth of the sea during the Gault period, by comparing the representative fossil genera with recent forms, by F. G. H. Price, F.G.S. The author is disposed to consider that the depth of the sea in which the Lower Gault was deposited did not exceed 100 fathoms.

Meteorological Society, April 21.—Dr. R. J. Mann, president, in the chair.—Mr. Scott read a paper, "Notes on sea temperature observations on the coasts of the British Islands." He said that it mainly related to the connection between sea temperature and the take of fish on the coasts, and he noticed the investigations formerly carried on by the Dutch and that now in progress under the direction of the Scottish Meteorological Society. He read a letter from Mr. F. Buckland on the subject, which, however, proposed a scheme of action which would entail heavy expenditure, while at present there was no satisfactory record kept of the take of fish on any of our coasts except those of Scotland. Mr. Scott then said that he had had some observations of sea temperature taken at some stations in the West of England and on the coasts of the Irish Sea, and had received some observations from Mr. W. Dymond and from Mr. N. Whitley, and he submitted some monthly mean temperatures from a few stations. He also stated that both the Trinity House and the Commissioners of Irish Lights had kindly consented to have observations taken at certain lightships, and that instruments had been supplied for the purpose, and the inquiry was in progress. In conclusion, he mentioned the steps taken by the German Government to investigate the temperature, &c., of the sea on their Baltic and North Sea coasts, and expressed a hope that our Government would undertake a similar inquiry.—Mr. Pastorelli read a paper on the errors of low range thermometers. He pointed out some of the difficulties which instrument-makers have to encounter in graduating thermometers from 32°·0 to 37°·9, the freezing point of mercury, as there is no intermediate fixed point. He believed that fairly accurate thermometers could only be obtained by calibration.—

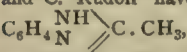
Mons. Louis Redier exhibited his new barograph, which was explained to the meeting by Mr. Symons.—Mr. Scott also exhibited Prof. Wild's pressure anemometer.

Physical Society, April 24.—W. Spottiswoode, F.R.S., in the chair.—Mr. J. Barrett exhibited an "auxiliary air-pump;" it is a modification of Poggendorff's arrangement for obtaining a Torricellian vacuum, and is allied in principle to the exhauster used by Geissler in the preparation of vacuum tubes.—Mr. Barrett also showed a hammer break for the instantaneous rupture of the current in the primary wire of an induction coil. It is impossible to explain it clearly without a diagram, but an upright swing hammer is kept constantly vibrating by the alternate action of a spring and the magnetised core.—Dr. W. H. Stone read a paper "On some points connected with wind instruments." He stated that discrepancies might be noted in the behaviour of air issuing from the side orifices of wind instruments. These discrepancies deserve attention, and may be accounted for by the laws of efflux. He showed that the stream of air from the side hole of a clarionet was sufficient to extinguish a candle, though the musical vibration was obviously in the main tube. It is usual to tune such instruments by introducing a resinous cement into the holes so as to diminish their calibre, but after a certain point is reached the rounded surface thus obtained ceases to produce an effect. If a short pipe of the same diameter as the orifice be now inserted, auxiliary vibrations are set up, and a definite note may be produced.. Dr. Stone was led to inquire whether the theorem of D. Bernoulli, or the particular part of it named after Toricelli, could be brought to bear on the question. The *vena contracta*, which in fluids reduces the efflux to 0·62 of the calculated amount, is also to be noticed in gases, and the nature of the effluent column of air is affected by three conditions: 1. The thickness of the wall in which the orifice is made. 2. The shape of the nozzle. 3. Friction in a long pipe. Some mathematical details were then given respecting these conditions, and it was admitted that the vibration in a musical tube must also exercise sensible influence. There are two functions in a side orifice in an instrument; the first is to cut off a portion of the tube, and by this means to raise the pitch; the second establishes a point of non-resistance in the wall of the tube, and thus acts by influencing the longitudinal vibrations. In the organ peculiar qualities of tone are often obtained by these side holes, as in the "Viol di Gamba" and "keraulophon" stops. In flutes, oboes, clarionets, and other instruments, much of the tone comes from the bell, even when the side holes are open. In instruments in which the holes are long, as in the bassoon, the holes themselves became separate vibrating tubes. This was shown by introducing tubes of different and increasing lengths, into an orifice in the side of an organ reed pipe. The friction at last became so great, and the secondary wave so strong, that the organ-pipe returned to its original pitch. A reed was also applied to a cylindrical tube, and it was shown that a sharp-edged orifice opened at the middle point of the tube rendered it impossible to produce any note until a cylindrical nozzle was introduced, when the octave was sounded freely. The general results proved that lateral holes had a double function, the pitch of the notes emitted varying with their size, shape, and length, the actual severing of continuity in the principal tube being a comparatively minor point. Dr. Stone then inserted three tubes varying in length from two to six inches in a cylindrical tube like that of a clarionet, at right angles to its length, the longest being placed at the the centre of the instrument, and the shortest at one-eighth from the mouthpiece. The same note was produced when each tube was used singly and when the three were employed, and Dr. Stone expressed a hope that a series of experiments would render it possible to develop curves in which the co-ordinates would be the lengths of the additional tubes and their position in the instrument. He also considered that a new instrument might be produced in which the side orifices acted purely as nodal points by the assistance of friction and the contracted vein.

Anthropological Institute, April 13.—Col. A. Lane Fox, president, in the chair.—A paper, largely illustrated by diagrams, was read by Prof. Rolleston, F.R.S., "On the people of the Long Barrow period." The author discussed at great length the following points:—1. The evidence existing for dividing the Long Barrow period into three epochs. In the earliest one the dead were interred unburnt in chambers, *i.e.* in graves walled with upright flags and communicating with the exterior by a passage or gallery, or at any rate constructed so as to admit of successive interments. In those chambers was found the greatest amount of manganous discoloration. In the second period the dead were still interred unburnt, but in cists, *i.e.* in closed stone receptacles not intended to be reopened, and having no gallery leading to the exterior. The third epoch of the Long Barrow period was distinguished, to the great regret of the craniographer, by the practice of cremation, a practice which, like that of burial in cists, and with even more probability, might be supposed to link the Long and Broad Barrow periods together. 2. The evidence for accepting what might be called the Ossuary theory for explaining the appearances met with in the Long Barrows, rather than the theory of successive interments as put forward by Prof. Nilsson, or the theory of human sacrifices and anthropophagy as suggested by the late Dr. Thurnam. What inclined Prof. Rolleston to the Ossuary theory was the fact that just those bones are found in connection most frequently which would, by virtue of their ligamentous or muscular connections, longest resist the dislocating effects of removal from a provisional to a permanent burial-place. 3. The evidence as to the mode of life prevalent in the Long Barrow period which the cranial and other bones of the persons buried or burnt in them furnished. Mr. Bertram F. Hartshorne exhibited and described objects of Pre-Hellenic age from Troy.

Berlin

German Chemical Society, March 22.—F. Gäss and C. Hell have observed a condensation of amylic aldehyde through the agency of carbonate of potash resulting in the formation of a body $C_{10}H_{18}O_2$.—C. Hempel has found amongst the products of oxidation of terpin a new monobasic acid, $C_8H_{12}O_4$, homologous with terebinic acid.—E. Prehn found that hydrochloric acid transforms mesaconic into citraconic acid.—E. Büchner, in distilling paramonobromaniline, has observed its transformation into aniline, dibromaniline, and tribromaniline.—R. Fittig and R. Mayer, continuing their communications on isomerism in the aromatic series, insist upon the transformation of all three bromophenols into mixtures of resorcin and pyrocatechin, a fact singularly affecting theoretical conclusions hitherto drawn from single experiments.—A. Schrohe observed allylene-sulphuric acid to yield not only mesitylene, but also acetone, by the action of water.—W. Lossen sent a short note on the reduction of metallic oxides by hydroxylamine, which is thereby transformed into N and H_2O.—C. Gosslich asserts that he has discovered a fourth isomeric bromobenzene-sulphonic acid.—H. Limpricht recommended measures of precaution to be taken in the determination of the solubility of salts.—D. M'Creath described substituted guanidines obtained through the action of anhydrides on guanidines, viz., benzoyl-triphenyl-guanidine, diacetyl-triphenyl-guanidine, and dibenzoyl-diphenyl-guanidine.—T. Jannasch has been able to transform bromomesitylene, $C_6H_2Br(CH_3)_3$, into tetramethylbenzene, a liquid isomeric with durene.—C. Liebermann and H. Troschke have studied the action of ammonia on alizarine. The products are compounds in which OH is replaced by NH_2, and 2OH are replaced by NH.—C. Liebermann and F. Palm exhibited crystalline compounds of hydrocarbons with the chloride and with the amide of picric acid.

April 12.—O. Brenken has studied what was generally considered as the melting of terchloride of iodine, and has found it to consist of a dissociation into monochloride and free chlorine.—P. Melikoff determined that at 77° ICl_3 is completely decomposed into ICl and Cl_2.—A. Michaelis and J. Ananoff, in treating $PCl_2.C_6H_5$ with zinc ethyl, have obtained diethyl-phenyl-phosphine, a liquid base, distilling at 222°, taking up 2HCl and 2Cl. Oxide of silver, exchanging O against Cl_2, produces an oxide with the latter body. $PC_6H_5(C_2H_5)_3I$ is a well-crystallised compound. Similar bodies have been obtained by the action of zinc methyl on phosphenyl-chloride.—A. Michaelis, by treating $PCl_2C_6H_5$ with PH_2 and water or alcohol, obtained a yellow powder of the formula $C_6H_5 - P = P - OH$, diphosphobenzol corresponding to a diazobenzol.—E. Benzinger, heating phosphenylic acid, $C_6H_5PO(OH)_2$ with nitric acid in sealed tubes, has obtained a crystalline mononitrophosphenylic acid, which with tin and hydrochloric acid yields the corresponding amido-acid.—H. Lange, in passing toluene and PCl_3 through a red-hot tube, was unable to produce phosphobenzyl-chloride, but obtained stilbene only.—A. Michaelis, who has lately expressed the constitution of phosphorus acid thus: $HPO(OH)_2$, defends his view against a paper lately published by Zimmermann.—F. Kammerer has fixed the melting-point of perchloride of antimony as − 6° C.—H. Köhler and B. Aronheim have treated iodide of isopropyl and chloride of benzyl with sodium, thus obtaining $(CH_3)_2CH.CH_2C_6H_5$, phenyl-isobutan.—H. Hübner proved that benzoic acid can liberate nitrobenzoic acid from nitrobenzoate of barium, although the latter is the stronger acid of the two. The experiment consisted in heating the solutions to 80°.—H. Hübner and C. Rudolf have obtained an ethenyl-phenylenediamine,  $C_6H_4\begin{matrix}NH\\N\end{matrix}\!\!>C.CH_3$, by treating orthonitroacetanilide with tin and glacial acetic acid.—O. Billeter has transformed sulphocyanate of phenyl into the sulphide by treating it with sodium-amalgam. Lead allyl sulphydrate and chloride of cyanogen have yielded allyl sulphocyanate to the same chemist; it is converted into the isomeric mustard-oil on distillation.—H. Limpricht communicated researches on derivatives of the three amidosulphobenzolic acids.—W. Weith, by heating chloride of ammonium with methylic alcohol to 280° for ten hours, has transformed it completely into trimethylamine and tetramethylammonium-chloride.

April 26.—Researches were read by A. Burghardt, on bibromobenzoic acid; by H. Glassner, on paraiodosulphotoluene, $C_6H_3.CH_3.I.SO_3H$; by T. Ebell, on nitrobenzonaphthylamide, $C_{10}H_6.NO_2.NH.CO.C_6H_5$, which was found to combine with iodide of amyl; by F. Meinecke, on derivatives of benzanilide; by E. A. Grete, on derivatives of metabromotoluene.—H. Hübner defended modern chemistry against attacks launched against it by Prof. Kolbe, and showed the insufficiency of the proofs hitherto furnished for the existence of four nitrobenzoic acids, four bihydrobenzene, and four bromobenzene-sulphonic acids. These doubtful cases of isomerism, which, if true, would be opposed to Kekulé's benzene theory, were also vigorously attacked by experiments published by A. Ladenburg, as well as by P. Griess and by E. Nölting. The constitution of benzene derivatives, viz., $C_6H_4Br.CH_3$ and $C_6H_3Br.NO_2.CH_3$, also formed the subject of a communication by E. Wroblewsky.—Mr. P. Siljeström defended his opinion on the density of gases under diminished pressure against that expressed by Mr. Mendelejeff.—A. Stutzer has tried the action of nitric acid on the fibre of grasses, and not finding benzene derivatives amongst the products, concludes that the fibre does not contain aromatic bodies preformed.—Dr. Ewald described an improved method for determining urea with hypobromite of sodium by ordinary volumetric analysis.—V. Mering reported on the action of digestion on sarcosine, arriving at the conclusion that urea and uric acid are *not* diminished in quantity in the urine of individuals fed with sarcosine. This is contrary to the observation published by Schultzen some years ago.—E. Fischer, in reducing a diazo-compound, $C_6H_5-N=N-NO_3$, with bisulphite of sodium, and treating the resulting compound, $C_6H_5-NH-NH.SO_3K$, with chloride of benzoyl, obtained the first of a new class of bodies:

$$C_6H_5-NH-N(CO.C_6H_5)_2$$

that is, an ammonia, NH_3, in which one H is replaced by an amido-group, NH_2. He calls this class of bodies *hydrazines*; the body whose formula is given above is dibenzoylated phenylhydrazine. By the action of water and hydrochloric acid it yields benzoic acid and a base, phenyl-hydrazine, $C_6H_5-NH-NH_2$, which forms well-defined crystalline salts with HCl, &c.

PARIS

Academy of Sciences, April 26.—M. M. Frémy in the chair.—The following papers were read:—On ascents to great heights, by M. Faye. M. Faye advocates strongly that the Academy should forbid any balloon ascent beyond 7,000 metres of elevation; he considers that any observations that might be made beyond that point will not be of any greater value than those up to that limit, and will certainly not outweigh the danger to life. He thinks that all aëronauts will respect the Academy's decision.—On the determination of ordinary alcohol when mixed with methylic alcohol, by M. Berthelot.—A note by M. A. Ledieu, on thermo-dynamical machines.—A note by M. Marès, on the results of the experiments made by the Commission investigating the diseases of vines in the Hérault.—A note by M. Dumas, on the use of alkaline sulphocarbonates against Phylloxera.—A note by M. F. de Lesseps, on the methods to be employed for the maintenance of ports.—A note by M. L. Saltel, on the geometrical principle of correspondence of M. Chasles.—On the curves of the order *n* with a multiple point of the order *n* – 1, by M. B. Niewenglowski.—On the development of the perturbating function according to the multiples of an elliptical integral, by M. H. Gylden.—On binauricular perceptions, by M. F. P. Le Roux.—On the determination of methylic alcohol in the presence of vinic alcohol, by MM. Alf. Riche and Ch. Bardy.—On the spiroscope, an apparatus for the study of auscultation, of the anatomy and physiology of the lungs, by M. Woillez.—A note by MM. G. Hayem and A. Nachet, on a new method of counting the blood-corpuscles.—On the wine-growing districts attacked by Phylloxera in 1874, by M. Duclaux.—M. Dumas then announced to the Academy the loss which science has sustained by the death of M. Anton. Schrötter, secretary to the Academy of Sciences at Vienna.—On the precipitation of silver by protoxide of uranium, by M. Isambert.—On the action of platinum and palladium upon the hydrocarbons of the benzenic series, by M. J. J. Coquillion.—A note by M. Peslin, on the law of diurnal and annual variations in the temperature of the soil.—On the theory of storms, by M. Cousté.—A note by M. U. Gayon in reply to M. Béchamp's paper on the spontaneous alterations in eggs.—On the helminthological fauna of the coasts of Brittany, by M. A. Villot.—On a new intermediary type of worms (*Polygordius?* Schneider), by M. Edm. Perrier.—On the ornamentation of striated wood-fibres and their relation to ordinary spotted fibres in the wood of certain species of Conifera, by M. G. de Saporta.—On the glacier deposits of the inferior valley of the Tech, by M. E. Trutat.—On the differences in the rising and setting of Mercury, Venus, Mars, Jupiter, and Saturn, as stated in the *Journal du Ciel* and in the *Annuaire du Bureau des Longitudes*, by M. J. Vinot.—On a method of re-establishing the concordance of the solar with the civil year, by M. Crampel.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—A Manual of Diet in Health and Disease: T. King Chambers, M.D., F.R.C.P., &c. (Smith and Elder).—The Journal of the Iron and Steel Institute, 1874 (E. and F. N. Spon).—Electricity; its Theory, Sources, and Applications: John T. Sprague (E. and F. N. Spon).—Researches in Chemical Optics: John H. Jellett, B.D. (Dublin University Press).—Journal of Proceedings of Winchester and Hampshire Scientific and Literary Society. Vol. i. Part iv. 1874 (Winchester, Warren and Son).—Meteorology of West Cornwall and Scilly, 1870 to 1874, and Observations on Sea Temperature, 1872 to 1874: W. P. Dymond, F.M.S. (Falmouth, Wm. Tregaskis).—An Address delivered by the President of the Meteorological Society at the Annual Meeting, January 20, 1875.—Journal of the Quekett Microscopical Club (R. Hardwicke).—Perthshire Society of Natural Science. Sixth Annual Report.—On Protoplasm: James Ross, M.D. (R. Hardwicke).—Commercial Handbook of Chemical Analysis, by A. Normandy; Enlarged and to a great extent re-written by H. M. Noad, Ph.D., F.R.S. (Lockwood and Co.)—Life of Sir Roderick Murchison, Bart., K.C.B., F.R.S.: Archibald Geikie, LL.D., F.R.S. (John Murray).—New Code Progressive Reader. Fifth Standard (Wm. Collins, Sons, and Co.)—Unseen Universe (Macmillan and Co.)—Year Book of Facts in Science and the Arts. Edited by Chas. W. Vincent, F.R.S.C. (Ward, Lock, and Tyler).—Thirteenth Annual Report of the Free Librarians' Committee (Birmingham, Hall and English).—Text-Book of Botany, Morphological and Physiological. By Julius Sachs; translated by Alfred W. Bennett, M.A., B.Sc., F.L.S., assisted by W. T. Thiselton Dyer, M.A., B.Sc., F.L.S. (Oxford, Clarendon Press).—Report of the Permanent Committee of the First International Meteorological Congress at Vienna, 1874 (H M. Stationery Office).—Climate and Time: James Croll (Daldy, Isbister, and Co.)—Fiji: Our New Province in the South Seas: J. H. de Ricci, F.R.G.S. (E. Stanford).—Journal of the Anthropological Society of Great Britain and Ireland, April to July 1874 (Trübner and Co.)—An Elementary Book on Heat: J. E. Gordon, B.A. (Macmillan and Co.)

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THURSDAY, MAY 13, 1875

LORD HARTISMERE'S VIVISECTION BILL

THE Bill brought forward in the Upper House by Lord Hartismere for regulating the practice of Vivisection deserves special attention on account of its being the first important legislative attempt to restrict the prosecution of physiological research.

It enacts that it shall not be lawful for anyone to perform a vivisection except in a place which is registered in pursuance of the proposed Act, the registration being in such form and under the management of such persons as the Secretary of State shall appoint. The registration certificate is to be renewed once a year; it may be cancelled at any time on its being proved that any provision of the Act has been contravened, and the place registered may be visited at any time by any inspector of anatomy. Complete anæsthesia is compulsory, and curare is not to be deemed to be an anæsthetic. The Secretary of State may grant special licenses for the performance of vivisections in which anæsthetics are not employed; there shall be paid in respect of every such license a sum not exceeding ten pounds, and each license is to continue in force for six months.

In the framing of this Bill there is a serious misrepresentation of the true requirements of the case. The source of error lies in the fact that it is taken for granted that there is only a single class of physiological workers. Such, however, is not the case; there are two distinct classes, and although we agree with the tenor of the Bill as far as one class is concerned, we are certain that it would so severely affect the other that its results would be seriously detrimental to the prosecution of physiological research in this country.

Among ourselves there are several scientific men who devote part of their life to the study of the problems of the vital mechanism. Some do so from the inherent interest of the subject; others from a desire to obtain a further insight into pathology and disease generally. In the course of their investigations it is now and then absolutely essential for the completion of a line of argument, or for the acquisition of the knowledge of the collateral phenomena attending some previously recorded result, that an experiment or experiments should be performed on a living animal. Those whose mental development leads them to conduct investigations of this character are frequently peculiarly unwilling to do so in public institutions. It is their spare minutes, when they are entirely their own masters, that they employ in their favourite study. Are they to be compelled, against their natural dispositions, either to obtain an official license for the performance of these experiments on their own premises, or, as an alternative, conduct them in some previously specially licensed establishment which is under the control of others? The necessity for such a method of procedure would deter many an excellent worker from commencing investigations which he recognises to be so much impeded by *legal* restrictions. There might as well be a tax on astronomers directing their telescopes to any special planet or to the moon. The public may feel certain that students of the class to which we refer will never go beyond the limits of the innate laws of sympathy present in all civilised humanity. Such do the most valuable work in a scientific point of view; and any legislative measure which in any way affects them injuriously, either by rendering the whole research apparently too formidable at the outset, or by the introduction of unpleasant details during its prosecution, ought most strenuously to be resisted. The power of turning to a practical end the results of inductive reasoning is the basis of the British nature. Inductive research cannot be had for money; it is always a labour of love; it is not fair to put impediments in the way of it.

The class of physiologists to whom legislative restrictions with regard to vivisection do apply, is the teachers. There is no doubt that those who assert that the performance of vivisectional demonstration is unnecessary will have the sympathy of the majority. A fact may be learned from books or by practical demonstration. As far as natural science goes, the extra time which has to be expended in obtaining the results practically is generally quite made up for by the accessory details introduced, which are many of them omitted in written or verbal descriptions. Observation is a far more sound basis on which to start fresh work than the knowledge acquired from books alone. The student should therefore, where nothing counter indicates, have the opportunity of repeating, on his own account, the experiments he reads of. In the case of practical physiology, however, another consideration has to be introduced. Here the subjects of experiment are sentient beings, and the question comes to be whether the advantages of the practical verification of fully described phenomena which involve pain are counterbalanced by the injustice done in the production of the pain itself. We think not, and are therefore fully in favour of legislative restrictions on the powers of those who wish to employ living animals for the purpose of demonstration, even where anæsthetics are employed, because there is a tendency among those who are in the habit of repeating experiments to neglect those parts of them which are not absolutely necessary. But any measure which in any way impedes original work, as does the Bill before us, ought, in our opinion, to be strongly opposed.

GEIKIE'S "LIFE OF MURCHISON"*

II.

Life of Sir Roderick I. Murchison, Bart., F.R.S. etc. Based on his Journals and Letters. With Notices of his Scientific Contemporaries and a Sketch of the Rise and Growth of Palæozoic Geology in Britain. By Archibald Geikie, LL.D., F.R.S., Director of H.M. Geological Survey of Scotland, and Murchison Professor of Geology and Mineralogy in the University of Edinburgh. 2 vols. Illustrated with Portraits and Woodcuts. (London: John Murray, 1875.)

MR. MALLET, in a memoir published in the *Philosophical Transactions* (vol. 163, p. 147), which has attracted attention as much for the boldness of its tone as for anything else, has laid down the dictum that no sound progress can be made in geology unless the investigator be also mathematician, chemist, and physicist. Now, Murchison was none of these, yet he would be a bolder man than the writer of that memoir who should affirm that no sound progress was made in geology by him.

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* Continued from p. 3.

It is true enough, no doubt, as Prof. Geikie says, that "he was not gifted with the philosophic spirit which evolves broad laws and principles in science," and he therefore contributed nothing to this branch of geology. It is strange, in fact, that when he did express any opinion on debated theories—and he did so frequently with vehemence—he generally took that side which the advance of science has condemned as untenable; so that the only assistance he gave to theoretical geology was that of affording the holders of any new theory the notorious advantage of having some one to argue against. He made no speculations himself, but only discussed those of others. In fact, "he had the shrewdness to know wherein his strength lay. Hence he seldom ventured beyond the domain of fact, where his first successes were won, and in which throughout his long life he worked so hard and so well. In that domain he had few equals."

But for the observation of geological facts there is no necessity for a universal acquaintance with science, however great an advantage such an acquaintance may be; and this is proved by the successful labours of many a field geologist—by the example of Wm. Smith, so often called the Father of English Geology, who had no such advantages, and by Murchison himself, as these pages of Prof. Geikie abundantly show.

Yet there are qualities requisite for such work as Murchison's, which are rarely so abundantly possessed as by him; they are, a keen perception of the really essential features of a district, or, as Smith somewhat quaintly expressed it, "a fine eye for a country;" a power of correlating apparently dissimilar objects; and last, not least, an untiring industry and perseverance that persist in pursuing an intricate subject until it is fully mastered. These appear in all his work, and are well brought out in his "Life."

Although the name of Murchison is now indissolubly connected with Palæozoic rocks, he did not begin his geological work among them, but among those easier Secondary rocks in which the order and arrangement is so much clearer. His first work, in 1825, was a "Geological Sketch of the North-western extremity of Sussex and the adjoining parts of Hants and Surrey," which was certainly up to the average geology of the time, and gave promise of better things in the future. Indeed, when it was thus seen that he had the ability, and intended to be a worker in the science, he was elected to the secretaryship of the Geological and fellowship of the Royal Society, rather from the hope of what he would do than from what he had done—and fortunately the hope was not disappointed.

His next work was the determination of the age of the coal-beds of Brora on the east coast of Scotland, in connection with which he described those remarkable remains of Secondary rocks so marvellously preserved on both sides of Scotland, and which have lately been the subject of such admirable and beautiful memoirs by Judd and others.

The difficulties he found in understanding some of the rocks he saw on this tour induced him to seek the co-operation of Sedgwick, and thus commenced that long and happy association of two great men, which, though clouded for a time, cannot be said to have been entirely broken up. We may mention here that these volumes are enriched with portraits of some of the chief geologists that have been or are, and nothing more life-like, as far as we know the originals, could be desired.

Another of his early works, in conjunction with Sedgwick, was an account of the structure of the Eastern Alps, which raised much discussion among European geologists, who have not finally accepted the conclusions they contended for—as, for instance, as to the age of the remarkable Gosau beds which they considered to be Tertiary—though they are now generally regarded as Cretaceous.

During all this time he had, like most geologists, avoided as much as possible what he called the "interminable Grauwacké." In the summer of 1831, however, he started with his wife and "two grey nags" to make the first attempt at unravelling the complicated features of these slaty rocks. He determined to begin at the top and trace the succession downwards. In this way he made out satisfactorily that summer the limits and range of the Ludlow rocks. Subsequent summers were devoted to the same work, and arrangements of the Silurian rocks of increasing accuracy were from time to time presented to the Geological Society until his final conclusions made their appearance in the "Silurian System."

On the controversy concerning the nomenclature of the Palæozoic rocks, which led to the painful estrangement between Murchison and Sedgwick, Prof. Geikie throws every possible light, and renders the whole matter perfectly clear. We cannot but think, however, that Sedgwick had more cause for complaint than Prof. Geikie would seem to admit, for if Murchison had no intention to disparage Sedgwick's work, he really, to a great extent, ignored it in comparison with his own. The facts are these. Murchison, in working downwards, described as Lower Silurian the rocks which formed his Caradoc and Llandeilo series, but without defining any satisfactory base line. Sedgwick, in working upwards, described as lying above a series of, at that time, unfossiliferous slates, a set of rocks which he called the Bala group, or Upper Cambrian. Now, though both these geologists went in company over both districts, they failed to discover that these two series were the same—in fact, they pronounced them distinct. Hence, when it was discovered that the one series, the Upper Cambrian, rolled over an anticlinal into the other, the Lower Silurian, each geologist blamed the other for the error. But in the meantime it was ascertained that the fossils were identical, and hence, "zoologically speaking," two different names could not be employed. If, as Murchison supposed, there was a total absence of organic remains beneath these disputed rocks, much might be said in favour of associating them in name with the fossiliferous Silurian rather than with the azoic Cambrian. Yet the manner in which this was done by Murchison, so fully explained by his biographer, leaves little surprise at Sedgwick's indignation, but only that he should have been so long in discovering the drift of what was being done. For in 1842 Murchison writes him a letter, begging the whole question by calling them Lower Silurian, as if there could be no possible idea of calling them Cambrian, and bidding Sedgwick, if he would retain the latter name, to find some fossiliferous beds *below*. This is followed by the complete dropping out of the name in his "Russia;" and when in after years a series of Lower Fossiliferous beds *were* found, Murchison still sought to include them under the title of Silurian. It is astonishing that Sedgwick should for so long have failed to perceive the drift of these changes—and when he did at length arouse himself he found half his Cambrian system gone, and not unnaturally felt that his friend had "stolen a march on him." Such appears from the data afforded by this work to be the true account of this controversy. In late years, however, chiefly owing to the labours of Mr. Hicks, much new light has been thrown on the succession of faunas in these earliest rocks, and it has been shown that by no means the greatest break in life occurs at the base of the Llandeilo rocks as described by Murchison; and it is therefore probable that the true limits of the two systems will have yet to be re-adjusted under the light of the new facts.

The "Silurian System" is a masterpiece of industry, perseverance, and comprehensiveness, and will be a classical work so long as Geology is a science; it is undoubtedly Murchison's *magnum opus*, and it led directly to those other researches by which he has also contributed so much to our knowledge. Thus it was, on being told that plants had been found in Silurian rocks in Devonshire, that he persuaded Sedgwick to accompany him there, when they found that the so-called Silurians were really of Carboniferous age—but on what did they rest? on a series of rocks with a peculiar assemblage of fossils, which gave them great difficulty at first, but which at last they recognised as a new system, the Devonian, with which they boldly classed the Old Red Sandstone, though no community of fossils had yet been proved. This last step, however, was fully justified, by Murchison's finding in Russia the fishes of the one associated with the shells of the other, and thus the Devonian system was settled on a firm basis.

The received classification, however, of the Devonian rocks was called in question by Prof. Jukes shortly before his lamented death; he assigned the greater part of them to the Lower Carboniferous system, and Prof. Geikie considers it to remain now an open question. He says: "They who have given most attention to this part of geology will probably most readily admit that, whether in the way of contest or not, the question must be reopened; that the accepted classification is far from being satisfactory, and that Jukes did a great service by boldly attacking it, and bringing to bear upon it all his long experience in the south of Ireland, which gave him an advantage possessed at the time by hardly anyone else." Whatever controversy, however, there may be on the classification of particular rocks, there can be no doubt that there is a distinct epoch of life between the Carboniferous and Silurian, and this Murchison and Sedgwick together first defined and established.

It was for the study of the Silurian system, too, that Murchison was led into Russia, and here it was that he found that large development of rocks containing a special fauna overlying the Carboniferous, to which he gave the name of Permian, and which formed the subject of several subsequent researches.

We are greatly indebted to Murchison for the introduction of good names into Geology. It was he who first proposed the use of geographical terms, so happily illustrated in "Silurian," which introduce no theory and no incongruity, such as is involved in calling rocks "transition rocks," or speaking of the Old Red Sandstone as represented by a clay. This method of nomenclature has been widely adopted and is now almost universal, and it has the further advantage of carrying with it information as to the locality where the series is typically developed.

The minor works of Murchison, in the shape of papers and addresses during the time that these "systems" were being worked out, were numerous, and, with the exception of his "Geology of Cheltenham," almost entirely confined to those Palæozoic rocks that had now become so familiar to him. But he brought forward now, not only his own researches, but those of more humble workers also, always giving them due credit. Amongst the most remarkable of these were the discovery of the curious crustaceans of a new type, now known as Eurypteridæ, in the Upper Silurian rocks of Lesmahagow, by Dr. Slimon. Another was the discovery of fossils in the ancient crystalline rocks of the Highlands, by Mr. Peach, which led ultimately to the last of the valuable series of labours that Murchison performed. In the same category as the above must be placed the publication of "Siluria," in which he embodied from time to time, not only his own original researches and additions to them, but the works of all who had laboured in that field, by which the work became at the same time less his own, and more comprehensive than the "Silurian System."

Finally, in the chapter entitled "The Foundatio Stones of Britain," Prof. Geikie gives an account Murchison's last geological work, that of making out the structure of the extreme north-west of Scotland, and discovering there the oldest rocks in Britain. Here, in 1858, he discovered three series of rocks, each overlying the one below unconformably, and it was in the upper of these three that Mr. Peach had found Lower Silurian fossils. If, then, the second be the Cambrian, the lowest must be a series still older. To this he gave the name of Fundamental Gneiss, but afterwards classed it with the Laurentian system of Sir E. Logan, which had been hitherto unrecognised in Britain. This work, however, valuable as it is, is of a different kind to that which made Murchison what he was—a master-builder in Geology.

His chief work consisted in uniting vast masses of rocks stretching over miles of country, variously characterised lithologically, and containing numerous different suites of fossils, into large comprehensive groups; in grasping the features by which many minor periods are united into single systems; in laying down the broad outlines in which the complete geological picture is to be traced. This is the work wanted at the birth of a science; it requires a peculiar power of mind, possessed in large degree by Murchison, who thus deservedly takes rank among the founders of Geology.

We leave Prof. Geikie's work with regret. Like him in writing it, we live again in reading it, with this hero of science; and no one can rise from its perusal without a deeper interest in the progress of knowledge, and especially of geology. A man of great power, thoroughly devoted to the advancement of science, and pursuing it with energy and discretion, is an example of which we cannot have too many; and the history of Murchison shows how much valuable material may yet be lying dormant in some who have as yet shown no devotion to anything but pleasure and sport.

MARSDEN'S NUMISMATA ORIENTALIA

Marsden's Numismata Orientalia. A New Edition. Part I. "Ancient Indian Weights." By Edward Thomas, F.R.S. (London: Trubner and Co., 1874.)

THIS is the first part of a new edition of "Marsden's Numismata Orientalia," on an enlarged scale, and is the reproduction of an essay published some years ago. As it treats of the earliest information that has come down to us of the system of monetary weights in use amongst ancient Eastern nations, it is considered as an appropriate introduction to subsequent numbers, upon the coins of various Eastern countries, to be contributed by other authors.

Mr. Thomas's essay is a work of considerable interest, not only as regards the information contained in it relating to ancient Indian weights and coins, but also for its philological and ethnological information. The earliest and most important authority cited is from the Sanscrit text of the original code of Hindu law by Manu, the exact date of which is undetermined. Although portions of it are assigned by some authorities between the twelfth and thirteenth centuries B.C., yet the body of the compilation is more generally referred to a period about 400 B.C.

The Indian weights mentioned in the Code of Manu were those of Central India, south of the Himalayas, and comprised between the rivers Indus and Ganges. They were in use after the occupation of this country by the Aryans, whose invasion from the north-west is referred to a period as early as 1600 B.C. Mr. Thomas, however, claims a still earlier origin for this system of ancient Indian weights, and that they were already in use before the Vedic Aryans entered India. The old system appears to have been based on the weight of native seeds. The principal unit was the *Rati*, the seed of the wild liquorice plant. A second unit or standard of weight is stated to have been the *Másha*, a small wild bean, which is also mentioned in the Code of Manu as a food grain. The following tables of monetary weight are taken from the ancient record, and include the smaller seed-grain weights, which, in the original Sanscrit text, are made to originate and lead up to the larger weights in metal, together with the smaller sub-divisions of the seed-grain unit. Their equivalent weight in Troy grains is given by Mr. Thomas as computed from the mean of experimental weighings of the several seeds, and as confirmed from the ascertained weights of less ancient Indian coins.

TABLE I.—*Minor sub-divisions of the Unit, the* Rati.

			Troy grain.
Rati (seed of wild liquorice)			= 1·75
Yava (barley corn husked)		= 1/3 Rati	= 0·5833
Gaura-sarshapa (white mustard seed)	= 1/6 Java	= 1/18 Rati	= 0·0972
Raja-sarshapa (black mustard seed)	= 1/3 Gaura	= 1/54 Rati	= 0·0324
Likhya (small poppy seed)	= 1/3 Raja	= 1/162 Rati	= 0·0108
Trasarenu (mote of sunbeam)	= 1/8 Likhya	= 1/1296 Rati	= 0·00135

TABLE II.—*Multiples of the Unit, the* Rati.

			Troy grain.
Silver.			
Rati			= 1·75
Mashaka (small wild bean)		= 2 Rati	= 3·5
Dharana Purana	= 16 Mashaka	= 32 Rati	= 56·0
Salamana	= 10 Dharana	= 320 Rati	= 560·0
Gold.			
Masha		= 5 Rati	= 8·75
Suvarna	= 16 Masha	= 80 Rati	= 140·0
Pala, or Nishka	= 4 Suvarna	= 320 Rati	= 560·0
Dharana	= 10 Pala	= 3200 Rati	= 5600·0
Copper.			
Karshapara		= 80 Rati	= 140·0

The fanciful introduction of the "very small mote which may be discerned in a sunbeam passing through a lattice" throws doubt on the practical use of this table; but there appears abundant evidence of the continued use of seed-grain weights in India from a very early period.

The earliest record of Indian measures of capacity, which are only incidentally mentioned in Manu, are quoted from a Sanscrit work for which very high antiquity is claimed. It gives the measures of *ghi*, or clarified butter, in equivalent weights of the *masha* and other multiples of the *rati*.

As to Indian measures of length, though permanently based upon natural units, as the digit, span, and cubit, yet the same seed principle is applied in Manu to the small sub-divisions of the digit. Thus, taking the cubit as the unit, the sub-divisions are stated to have been as follows:—

Hosta (cubit).	
Vitasti (span)	= 1/2 Hosta
Angula (digit)	= 1/12 Vitasti
Yava (very small barley corn)	= 1/8 Angula
Yuka	= 1/8 Yava
Liksha (poppy seed)	= 1/8 Yuka
Balagra (hair's point)	= 1/8 Liksha
Renu	= 1/8 Balagra
Transvarenu (mote of sunbeam)	= 1/8 Renu

The *Hosta*, or cubit, was thus equal to twenty-four digits, or six palms. Mr. Thomas does not assign any particular length to the cubit of *Manu*, but inferentially defines its length from the determined length of the Sikendari *gaz*, or yard, at the end of the fifteenth century, which is rather more than thirty imperial inches. This *gaz* is stated to have been equal to 41·5 digits, and the digit is computed as being equal to 0·72976 inches. This would make the ancient Indian cubit equal to above 17·5 inches.

Mr. Thomas considers that the system of Indian weights here described was indigenous, and he differs from Don V. Queipo, who traces the derivation of the Indian system of weights to primary Egyptian sources. He prefers the "wise reserve of Boeckh," who expresses himself in the following terms:—

"In cases where the weights of measures of different nations are found to be in a precise and definite ratio one to the other—either exactly equal, or exact multiples and parts of each other—we may fairly presume, either that the one has borrowed from each other, or that each has borrowed from some common source. When the ratio is inaccurate or simply approximative, it is to be treated as accidental and undesigned."

The more recent discovery, since the publication of Don V. Queipo's work, of the unit of ancient Egyptian weight, the *Kat* = 140 grains, equivalent in weight to the Indian copper unit, the *Karshapara*, to the gold *Suvarna*, and to one-fourth of the silver *Suvarna*, tends to confirm Don V. Queipo's hypothesis of the identity of the practical units of Egyptian and Indian weights. The Indian cubit of 17·5 inches, divided into twenty-four digits, is also almost identical with the ancient Egyptian natural cubit of six palms and twenty-four digits. But it appears to be now impossible to determine whether these Indian units were derived from the Egyptian, or both from an earlier common source; although we may fairly assume that this natural cubit was of the same length as that used by Noah before the Deluge. Mr. Thomas's hypothesis of the lesser Indian unit of weight and of length, and of the scale of multiples and parts, is, however, probably correct, as being derived from natural and local sources.

OUR BOOK SHELF

Arboretum et Fleuriste de la Ville de Paris. Description culture et usage des Arbres, Arbrisseaux et des Plantes herbacées et frutescentes de plein air, et de serres, employées dans l'ornementation des Parcs et Jardins. Par A. Alphand. Folio, pp. 110. (Rothschild, Paris.)

ORNAMENTAL gardening, among other things that added to the attractions of the city of pleasure, was greatly fostered during the latter part of the reign of Napoleon III., and does not appear likely to languish under the Republic. The magnificent publication, "Les Promenades de Paris," by the author of the book now before us, is a costly work, known to comparatively few people in this country. We presume that the present volume is regarded as an appendix or supplement to the work named, otherwise we cannot account for the publication of what is little more than a catalogue of names in so unwieldy a form.

An enumeration of the plants grown for the embellishment of the parks and gardens of Paris, in a handy octavo form, would be welcome to almost every lover of horticulture; but the object of the compiler of the "Arboretum et Fleuriste" was doubtless such as we have indicated. It is printed on one side of the paper only, and the matter arranged in columns, giving the names, native countries, soil, use, height, form of leaves, colour of flowers, &c., of the various plants. As a horticultural catalogue the work is fairly well executed, but, like most gardening books, it contains errors that have been copied from book to book, though they were cleared up long ago. In the first part of the work the author has indulged in an attempt to introduce a reform in botanical nomenclature; why it was not carried through we are not told, probably for the reason that, however desirable reformation may be, this one would scarcely receive any support from botanists. It consists in giving all substantive specific names an adjectival form, and, a less justifiable act, of changing the terminations of good Latin names. Thus, for example, *Pinus Coulterii*, *Hartwegii*, and *Fenzlii*, become *P. Coulterea*, *Hartwegea*, &c. Objections might be urged against this course; but why should we change *Benthamiana* and kindred names into *Benthamea?* And *Pinus inopsea* for *P. inops* is quite inadmissible.

The information under the several headings is usually not inaccurate, but somewhat loose. Thus, under the genus *Magnolia*, Pennsylvania is given as the native country of *M. acuminata*, Carolina of *auriculata*, Virginia of *glauca*, and so on; whereas these trees have a much wider range of distribution. Again, under *Cratægus coccinea*, we are told that the specific name indicates scarlet flowers; but the flowers are white, and the fruit scarlet. But as it is not a botanical work, it is scarcely fair to criticise it by a botanical standard, though it is scarcely excusable to give North Africa as the native country of *Calla Æthiopica*, New Zealand of *Caladium esculentum*, &c. *Libocedrus decurrens* is referred to *Thuja gigantea*, and the true *T. gigantea* to *T. Menziesii;* but the synonomy of these plants has long been cleared up even in gardening books.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Prof. Willis's Mechanical Models

THERE is a slight error in your account of the disposition of Prof. Willis with regard to his mechanical models in your last impression (p. 14).

Prof. Willis did not put any price upon his models; but by his will, dated May 11, 1872, directed that his "mechanical models" should be "offered to the University of Cambridge at a price to be fixed by the valuation of some competent appraiser to be nominated and chosen" by his executors.

In consequence, we have caused the models to be so valued, and fixed upon the sum named (1,200*l*.) after due consideration of the means of the University and the requirements of the estate.

A Syndicate was appointed on April 29 to consider whether the whole or a part of the collection shall be purchased. In the event of the University declining to purchase, the portion rejected will be offered for sale by public auction or private contract.

JOHN WILLIS CLARK
W. H. BESANT
Cambridge, May 9 Executors to the late Prof. Willis

Ants and Bees

IN NATURE, vol. xi. p. 306, Mr. Alfred George Renshaw refers to and criticises a paper on "Ants and Bees," lately read by Sir John Lubbock, and assumes, or seems to assume—and the language quoted justifies such assumption—that Sir John advanced the idea that bees have no means of communicating knowledge to each other.

It seems strange to me, who have been all my life familiarly acquainted with the working of bees, that anyone should doubt their power of communicating knowledge. The very idea there advanced, that "if the bees had the means of communicating knowledge, those bees would have told the others in the hive where they could obtain a good store of honey with a very little trouble, and would have brought a lot back with them," I have seen proved and illustrated hundreds of times.

Bee-hunters understand this faculty in the bee perfectly well, and turn it to a good account. Going to a field or wood at a distance from tame bees, with their box of honey, they gather up from the flowers and imprison one or more bees, and after they have become sufficiently gorged, let them out to return to their home with their easily-gotten load. Waiting patiently a longer or shorter time, according to the distance of the bee-tree, the hunter scarcely ever fails to see the bee or bees return, accompanied with other bees, which are in like manner imprisoned, till they in their turn are filled, when one or more are let out at places distant from each other, and the direction in each case in which the bee flies noted, and thus, by a kind of triangulation, the position of the bee-tree proximately ascertained.

Those who have stored honey in their houses understand very well how important it is to prevent a single bee from discovering its location. Such discovery is sure to be followed by a general onslaught from the hive unless all means of access is prevented. It is possible that our American are more intelligent than European bees, but hardly probable; and I certainly shall not ask an Englishman to admit it. Those in America who are in the habit of playing first, second, and third fiddle to Instinct will probably attribute this seeming intelligence to that principle.

It seems to me, and I think it may be so concluded on scientific principle, that there is no difference, except in degree, between the intelligence, or whatever it may be called, of man and of lower animal life. If the honey-bee, the ballooning spider, the agricultural ant, or the dog, is governed wholly by instinct, then it seems reasonable to infer that man is also governed by instinct. If all the actions of lower animal life are automatic, on what principle shall we say that man's are not automatic? If man builds his house, and, intending to furnish it and lay in a stock of provisions, ascertains from his neighbour where he can get the most at the cheapest rate, does he act on any principle different from the bees, who build their house and jointly or separately ascertain where the best stock of honey can be obtained?

In regard to selfishness, I think the bee has the advantage of man. In my own garden, where I have had standing always from ten to fifty swarms, and over which I thought I was watching with almost a fatherly affection, I have learned how utterly selfish I was in looking forward to autumn, when, by the destruction of the industrious and unselfish bees, I could lay in for my own consumption what they had so laboriously gathered in the summer to sustain each other through the winter. I learned, from their unselfishness, to divide with them, always leaving enough to sustain the colony till the spring should again bring the flowers.

I think, too, that both Sir John Lubbock and your correspondent are mistaken as to the object of beating pans, sounding horns, and making other hideous noises in hiving bees. The object is not, as Sir John intimates, originally to drive away evil spirits, or to assert ownership, as indicated by Mr. Renshaw. It is simply, as everyone knows who ever thumped on a pan, sounded a horn, or yelled through a speaking trumpet on such an occasion, to drown the voice of the queen or guides who are to conduct the swarm to the new home which members of the community who had been sent out, as the Israelites sent forward Joshua and others, had found for them.

Mr. Renshaw's law is probably good, but does not apply in the case trying. JOSIAH EMERY

City of Williamsport, Pa., U.S.

Flowering of the Hazel

IT was with great interest that I read the communication from F. D. Wetterhan, in NATURE, vol. xi. p. 507. But I cannot help expressing quite a different opinion as to the bearing of the interesting fact that proterandrous and proterogynous individuals are to be found in the same locality. From the structure of the flowers and from insects never visiting the stigmas, I am convinced that the hazel is a strictly anemophilous plant; that the red colour of its stigmas is solely an effect of chemical processes connected with the development of the female flowers to maturity, just in the same manner as in the female flowers of the larch-tree and some other Coniferæ; and that likewise the coexistence of proterandrous and proterogynous individuals in the hazel relates solely to the influence of the wind, and not at all to the agency of insects.

Whilst in Primula, Pulmonaria, and many other entomophilous plants, so admirably treated of by Charles Darwin, two kinds of individuals, viz., long-styled and short-styled ones, have originated from the positions of the anthers and the stigmas diverging in different individuals in opposite directions—among the anemophilous plants in *Juglans regia* * and *Corylus avellana*, among the entomophilous ones in *Syringa vulgaris* † and *Veronica spicata*, ‡ two kinds of individuals, namely, proterandrous and proterogynous ones, have originated from the periods of development of the anthers and stigmas diverging in different individuals in opposite directions. The effect in the two contrivances has been the same, cross-fertilisation not only between different flowers, but also between different branches, having become indispensable.

In dimorphous species, this cross-fertilisation, as is known, is effected by the visiting insects touching with the same part of their body the anthers of the long-styled and the stigmas of the short-styled form; and with some other part of their body the anthers of the short-styled and the stigmas of the long-styled form. This kind of intercrossing can apparently never be effected by the wind; whence long-styled and short-styled (dimorphous) species are never to be found among anemophilous plants. But in these the coexistence of proterandrous and proterogynous individuals produces the same effect, the pollen-grains of the proterandrous individuals, of course, being transported by the wind only to the stigmas of the proterogynous ones, and *vice versâ*.

Lippstadt, May 1 HERMANN MÜLLER

Variable (?) Star in Sextans

THE following may be of interest to the readers of your Astronomical Column:—

About 2¼° *north* of, and a little *preceding* λ Hydræ (4 mag.), is a star marked 5th mag. in Harding's large *Atlas Novus Cœlestis* (1822). This is now invisible to the naked eye, and of about mag. 7. It is 19662 in Lalande's Catalogue, in which it is rated at 4½ mag. It seems difficult to understand how excellent observers like Harding and Lalande could have made a mistake of 2 magnitudes in the estimation of a star's brightness, particularly as it is closely preceded by a 7½ mag. star (Lalande, 19646). So that probably this star has faded since 1822. Its position for the beginning of the present year is in R.A. 9h. 57m. 30·46s., and N.P.D. 98° 58′ 0″·42.

Punjab, India, April 3 J. E. GORE

Equilibrium in Gases

MR. NICHOLS, in NATURE, vol. xi. p. 486, advances the opinion that in a vertical column of gas at rest the temperature does not tend, as generally believed, to become equal throughout, but that such a column is in a state of thermal equilibrium when the temperature diminishes at the rate of 1° centigrade for every 233 feet of ascent (or 1° Fahr. for every 129 feet). This is a question of thermo-dynamics, and I am not mathematician enough to offer any opinion on it from the theoretical point of view, but it seems inconsistent with well-known meteorological facts. Were it true, there would be, as Mr. Nichols points out, a constantly renewed tendency for the lower strata to flow upwards in consequence of their higher temperature and consequent relative expansion. Such a tendency is no doubt very common, but Mr. Nichols's theory would require it to be universal, and it does not appear to exist in the absence of direct solar heating. Cumulus cloud is an infallible proof of the presence of ascending columns of air, and according to the report of the Austrian Polar Expedition in NATURE, vol. xi. p. 415, cumulus is never seen in the Arctic winter; and I have somewhere read the same respecting the Siberian winter. The true cause of the accumulation of heat in the lower atmospheric strata, to which upward currents and the formation of cumulus is due, is, I have no doubt, that usually assigned—namely, that the atmosphere is more pervious to the heat of the sun than to heat radiated back from the earth; so that, as I think Tyndall expresses it, the sun's heat is caught as in a trap. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim,
April 30

Curious Phenomenon of Light

ROWING on Loch Lomond recently, above Luss, there were seen to the north-west, at an apparent distance of about 100 yards, two bright lines of prismatic light, 60° apart and on the level of the water. Their length seemed to equal the breadth of a rainbow. Their violet ends were towards each other, and were joined by a line of dull white light, to the middle of which the sun and the spectator were at right angles. Standing in the boat, the colour and brilliancy were lost, and only a diffuse white light was visible. The time was 10 A.M. The sun was hot, the sky cloudless, the air hazy and still, and the loch a mirror. This apparition fled before our approach for some minutes, till dispelled by a slight breeze, which rippled the water.

Luss WM. M'LAURIN

Destruction of Flowers by Birds

I ENCLOSE some flowers of the common blackthorn, that I suppose to have been snipped off by birds. The bushes were growing in the outskirts of a wood, in a very sequestered situation (near Dunstable). The upper branches appeared to have chiefly suffered. The grass below was quite conspicuously starred with the fallen blossoms. I can hardly think that human intervention had anything to do with it. R. A. PRYOR

Hatfield, May 5

[In the accompanying specimens the limb of the calyx (carrying the stamens and petals) had been neatly cut away from the tube.]

OUR ASTRONOMICAL COLUMN

ORBITS OF BINARY STARS.—Dr. Doberck, of Colonel Cooper's Observatory, Markree, Co. Sligo, has published the results of a new investigation of the elements of the revolving double star σ Coronæ Borealis, in which measures to the end of 1872 are included. The period of revolution is increased to 843 years, which is longer than any yet assigned to this star. Dr. Doberck's comparison of his orbit with the measures of the late Rev. W. R. Dawes affords another proof of the remarkable excellence of that astronomer's observations, particularly in the last fifteen years of the period over which they extend, when he had the command of comparatively large telescopes; and a similar remark applies to the measures of Baron Dembowski, who during upwards of twenty years has produced work of the greatest value in this department of astronomy. Dr. Doberck also gives us a provisional orbit for τ Ophiuchi, which Sir William Herschel in 1783 considered the closest of all his double stars; and after appearing single to Struve with the Dorpat refractor in 1825, was oblong in 1827, and is now an easy object. The period assigned is 185 years, with a peri-astron passage, 1820·63; the semi-axis, 1″·11.

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* Delpino, "Ulteriori osservazioni," Parte II. fasc. ii. p. 337.

† H. Müller, "Befruchtung," &c., p. 339.

‡ Ibid. p. 285.

The Star Lalande 19662 (Sextans).—Mr. J. E. Gore, of Umballa, Punjab, in a letter printed in another column, directs attention to the probable variability of this star. It was observed by Lalande, 1798, April 10, "Histoire Céleste," p. 330, where its magnitude is entered 4½, as in the reduced catalogue published by the British Association (which, by the way, as well as the other two catalogues prepared at the instance of that body, is unfortunately becoming scarce). It appears in Heis's Atlas as a 6·7; but after searching through the modern catalogues where it was likely to be included, we have only discovered a single meridian observation by Lamont in his Zone 314, on 1845, April 5, when it is called 7·8. It does not occur in Argelander's "Uranometria," nor was it observed by D'Agelet, Bessel, or Santini.—Another of Lalande's stars, No. 23726 in Corvus, is in all probability variable. He estimated it 7½, 1795, May 10, and Bessel in May 1824 called it 8; Heis, however, saw it as a *fifth* magnitude. What is the actual degree of brightness? The star's position for the commencement of the present year is in R.A. 12h. 37m. 2s., and N.P.D. 103° 10′·3.

The Star 61 Geminorum.—The Rev. T. W. Webb has remarked the probable variability of a small companion of this star, distant about 1′, and not far from the circle of declination to the south (estimated angles from 160° to 190°), and appears inclined to identify it with Smyth's companion of the 9th magnitude, for which he gave, 1835·85, position 110°·0, distance 60″. Smyth's estimates of magnitude down to 9 may be generally relied upon, though for smaller stars he is often wide of the mark, according to our present standard. It is very possible that he may have caught one of the minor planets close to 61 Geminorum; his angle, though it has only his lowest weight, differs considerably from recent estimations for the faint star. Our principal object in referring to the Rev. T. W. Webb's remarks is, however, to suggest that 61 Geminorum may be itself variable; D'Agelet considered it 6 in October 1784. Piazzi observed it ten times on the meridian, and estimated it 7·8; it is 7 in Lalande, 6·7 in Taylor's volume for 1834–35, 6 in the "Uranometria" and Heis's Catalogue, 6·5 in "Durchmusterung," and 6·3 in the Radcliffe Observations, 1870. The deep yellow colour noticed by Smyth, and now stated to have disappeared, may perhaps be considered by some readers as an indication in the same direction.

Cometary Astronomy.—The *Astron. Nach.*, No. 2,034, contains a fine series of observations of the faint comet discovered by Coggia, 1874, August 19, taken at the newly-erected observatory of Col. Tomline, Orwell Park, Ipswich: it extends to the middle of November, and will no doubt be of material service in the final determination of the orbit. (The position of the Orwell Park Observatory is in long. 4m. 55·8s. E., and lat. 52° 0′ 33″). Vienna observations of the same comet appear in No. 2,035 of the above-named periodical, but extend only to October 19: they are accompanied by positions of Winnecke's Comet (1874, April 11) to June 17, and of the comet detected by Borrelly (July 25) to October 19.—In No. 2,036, Dr. Sandberg has given elements of the elliptic comet of Tempel, 1873, II., which will be preferable to any hitherto published. It will be remembered that this comet, near the preceding aphelion passage, experienced very heavy perturbations from the action of Jupiter, having approached that planet in January 1870 within 0·35 of the earth's mean distance from the sun. In the instantaneous ellipse at perihelion, 1867, May 23, the period of revolution was 2,080 days: at the last passage by the same point of the orbit, the perturbations had increased the period to 2,179 days. Other elements for 1873 are: semi-axis major, 3·2889; semi-axis minor, 2·9169; perihelion distance, 1·7695; the period in years is 5·965, so that we may expect to see the comet in the spring of 1879 under similarly favourable conditions for observation to those of 1867 and 1873.—In No. 2,037 we have definitive orbits (parabolic) for Comet 1870, IV., which was observed for only seven days, and of Comet 1871, II., both by Herr Schulhof, of the Observatory at Vienna. As the manner in which the elements are expressed may not be readily understood by the uninitiated in such calculations, we transcribe the orbits in the form that has so far been adopted in our catalogues. The perihelion passage is expressed in Greenwich time, and the longitudes are from mean equinox at commencement of the year.

	Comet 1870, IV.	Comet 1871, II.
Perihelion passage ...	Dec., 19·87609 ...	July, 27·01925
Long. of perihelion ...	4° 8′ 56″ ...	115° 35′ 44″
„ ascending node	94 44 43 ...	211 54 40
Inclination	32 43 35 ...	78 0 36
Log. perihelion distance	9·590242 ...	0·031763
Motion ...	Retrograde. ...	Retrograde.

*LECTURES AT THE ZOOLOGICAL GARDENS**

III.

May 6.—Mr. Garrod on the Deer Tribe.

THE Deer may be defined as those Ruminant Artiodactylate animals in which deciduous horns are developed, and the young are spotted. Some, namely the Musk Deer (*Moschus*) and the Water Deer (*Hydropotes*), never have antlers; in both these the young, however, are spotted, as they are not in any of the hollow-horned Ruminants.

The degree of development of the antlers is closely related to the size of the species. In the small Pudu Deer and the Muntjacs they are simple or but slightly branched; whilst their branching is very considerable in the large Reindeer and Wapiti. The typical antler seems to consist of a main stem or beam, with a small basal, anteriorly directed tyne, the brow antler. The apex of the beam bifurcates, one branch being directed forwards, and a little external to the brow antler; the other starts from the inner side of the posterior surface. In one well-marked group, the *Elaphine*, the anterior of these upper branches is inconsiderable and does not branch, the posterior enlarging and branching in most—becoming palmated in the Fallow Deer. The larger species of this elaphine section, including the Wapiti, Maral and Red Deer, possess a second brow antler; whereas in the smaller species this is not found (*e.g.* the Fallow, Formosan, Mantchurian, and Japanese Deer). In the Mesopotamian Deer, recently discovered by Sir Victor Brooke, which is intimately related to the Fallow, the palmation is found in the basal portion of the antler, including the brow antler, together with extra small tubercles very frequently found in that region.

In the group of Deer called *Rusine* the bifurcation is more equal, and when there is a further branching, the anterior as well as the posterior branch participates in the division. The brow antler is simple. This type of antler is found in its most uncomplicated condition in the Sambur of India, and the closely allied species *Rusa equinus*, *swinhoii*, &c. of the Malay region and

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* Continued from p. 9.

Formosa, as well as in the smaller Axis, Prince Alfred's and Hog Deer. In the Siamese Deer, named by Mr. Blyth after Mr. Schomburgh, the brow antler is long, whilst each of the two branches of the short beam again divides in a very regular manner, the ultimate tynes being of nearly equal length. In Duvaucel's Deer, from India, the beam is longer than in the last-named species, and the branching is very similar, except that the posterior bifurcation is less developed than the anterior. This reduction is carried to an extreme in Eld's Deer, from Eastern India, where the anterior division of the antler is very large and curved forward, whilst the posterior is represented by a minute tyne. The gradation between these three forms was demonstrated by Mr. Blyth. In the Reindeer the general conformation of the beam very closely resembles that of Eld's Deer, but with this rusine peculiarity, the strangely palmated brow antler is double, as only elsewhere occurs in the elaphine type. In the American Roes a similar conformation obtains, the brow antler being small in the Virginian Deer and almost absent in the Mule Deer, which latter species in the branching of the beam very closely agrees with both Duvaucel's and Schomburgh's Deer.

The South American Guazupucu (*Blastocerus paludosus*), which differs considerably from the Mazame, a species generally supposed to belong to the same genus, has the anterior bifurcated tyne. This may be the modified brow antler, as may be the similar branch in the Chinese Elaphure discovered by the Père A. David, both these species having a simple, or comparatively simple, posterior beam, and no gland on the outer side of the metatarsus.

The interpretation of the affinities of the Roebuck by means of its horns is not easy. In that species there are three small tynes, the anterior being situated higher up than is usually the case with brow antlers; and the two posterior much like those of the Hog Deer. In the last-named species, however, the brow antler is not low, and it is not difficult to imagine it being carried a little further up. On this assumption the Roebuck is the only European representative of the rusine type.

The simple nature of the antlers in the Brockets of South America and the peculiar Muntjacs of the Indian region, in which the horns are attached on the top of elongated pedestals, makes it impossible to decide, from them alone, the forms to which they are nearest allied.

As far as the hornless Musk and Water Deer are concerned, Sir V. Brooke has shown in how many points they differ from one another; whilst Prof. Flower, at a recent meeting of the Society, has demonstrated to a certainty that the former of them is not at all related to the Chevrotains, which they so closely resemble in size and general contour, and with which they have generally been associated.

The horns of the Elk do not agree with any of the above-described forms. The fan-shaped palmation into which they spread is based on a radiating framework, and no specialised brow antler is to be seen.

With reference to the geographical distribution of the Deer, none are to be found in the Australian or Ethiopian region, the Barbary Deer being the only member of the group found in Africa at all, and that north of the Sahara. The Elk is found both in North America and Northern Europe, as is the Reindeer. The larger Elaphines are represented in North America by the Wapiti, and by several closely-allied species distributed throughout the Palæarctic region as defined by Mr. Sclater to include Europe, North-west Africa, and Asia with the exception of India and the Chinese Empire. The smaller Elaphines abound in Japan, China, and Formosa. The true Rusas are most numerous in India and the Indo-Malay Archipelago, the most recently discovered species, named by Mr. Sclater *Rusa alfredi*, having been obtained by the Duke of Edinburgh from the Philippines, whilst *R. Swinhoii* is from Formosa.

Mr. Swinhoe's new Water Deer abounds at and near Shanghai, whilst the equally peculiar Elaphure probably has its home in South-west Mantchuria, though it exists in large numbers in a semi-domesticated state in the Imperial Park at Pekin, together with commoner species. The Musk Deer comes from India and the country north of it, and the Muntjacs are found in India and China, as well as the intermediate regions. The Cervidæ are also represented in North America by the Virginian, Mexican, and Mule Deer; the Guazus, Guemuls, and Brockets replacing them in the southern continent.

(*To be continued.*)

THE IRON AND STEEL INSTITUTE

THIS Association may now be fairly considered as having become an established institution in the country, and is to be congratulated on the success it has achieved in its attempt to introduce something like scientific method into the important industries with which it is connected. It is undoubtedly doing excellent work, and if it adheres steadily to its purpose, and goes on as it has begun, it will help greatly in enabling our iron and steel manufactures to keep pace with the rapid progress which is being made on the Continent and in America.

As we have already intimated, the Institute held its annual general meeting in London on Wednesday, Thursday, and Friday, the 5th, 6th, and 7th inst. The Report which was read was very encouraging; the number of members is now 832, and the financial statement is highly satisfactory.

The Bessemer Medal for 1875 has been awarded to Dr. Siemens, F.R.S., in recognition of the valuable services he has rendered to the iron and steel trades by his important inventions and investigations. Besides a number of foreign gentlemen, Dr. Percy, of the School of Mines, was elected an honorary member. The next provincial meeting is to be held in Manchester early in September.

Mr. Lowthian Bell, after a short address, resigned the chair, to which Mr. William Menelaus was elected. The address of Mr. Menelaus was mainly concerned with recent improvements in the manufacture of steel. Mr. Menelaus has evidently correct notions as to the method by which the industries with which he is connected are to be made the most of. "As an iron maker," he said, "my mission has been to bring into profitable use the valuable inventions of Bessemer, Siemens, and others, and to apply the scientific research of men like Mr. Bell to the improvement of old and new processes."

On the evening of Wednesday Mr. Warrington W. Smyth delivered a valuable lecture on "The Ores of Iron considered in their Geological Relations." Mr. Smyth directed attention to the oxides as met with by themselves, or combined with water or carbonic acid, and which formed the great bulk of the material employed in iron making. First in order of the ores thus limited was magnetite. This mineral, with 72·41 per cent. when pure, was the fine rich ore which had been worked with great success for centuries in several of the Scandinavian mines. In Italy fine examples of magnetite were also found, as well as in several widely-separated places in North America. Magnetite only occurred in a few localities in Great Britain, amongst which the vicinity of Penryn, in Cornwall, and Hey Tor, near Bovey, in Devon, were mentioned. The next species noticed by the lecturer was hæmatite. This ore, so little recognised thirty years ago, was now too well known to require to be enlarged on. He next described the curious ores named bauxite and wöchenite, in which alumina takes the place of the sesquioxide of iron, turgite, göthide, limonite, chalybite, the last-named often mixed with other ores on a large scale. The most important deposit of this last-named ore was contained in the range of veins occupying a length of some thirty miles in Somerset and North Devon, from the Raleigh's Cross westward to near Ilfracombe. Proceeding next to show the relationship between the oxides, the lecturer exhibited a specimen of ore having the appearance of chalybite or spathic ore, being covered with the large rhombohedral crystals characteristic of that species, but which the presence of the brown streak and of water and the percentage of iron proved to have been turned into brown ore. A fragment from the lodes of the Deerpark in Exmoor, next shown, had also lost its carbonic acid, had acquired oxygen and water, and actually become a different substance. It had been argued that the change commenced with the formation of the more hydrated species, and passed through successive stages to those with the least amount of water; but on that point evidence was as yet defective. The brown ores were undoubtedly (for the process might be watched in the workings) formed by another series of changes from pyrites through the sulphate of iron. The crystals of brown ore, in the form of pyrites, were among the best known pseudomorphs, and there were localities which invited the inference that this action had taken place on an important scale. Mr. Smyth, in concluding, said he would not, in the present brief sketch, venture upon the vexed question of the original deposition of the great northern masses of hæmatite, although strong arguments for their having been chalybite might be adduced from the occurrence of limestone fossils turned into red ore. He brought under notice another change of condition among the oxides of iron. It was a significant fact that magnetite was characteristic of the older formations—of those bodies of rock which had during the longest period of time been exposed to the influences which bring about metamorphosis and change of substance. In the Perran lode small portions of magnetite had been formed among the brown ores near the surface. In some of the Cornish copper lodes specimens of magnetic ore had occurred which looked very much as if they had been carbonates, and amongst the beautiful red ores of Siegen small grains of magnetite appeared to testify to a partial change, while there appeared to be sufficient grounds for believing that, in many cases at least, this last change in the degree of oxidation might be produced by the ordinary action of natural causes.

One of the most interesting papers from a scientific standpoint was that read on Thursday by Sir J. G. N. Alleyne, Bart., "On the estimation of small quantities of Phosphorus in Iron and Steel by Spectrum Analysis." This paper forcibly shows the valuable practical results which may follow from lines of pure scientific research. We shall return to this paper in a future number.

Mr. Lowthian Bell then read a long account of his visit to mines and ironworks in the United States. He began by saying that in the year 1871, one half of the iron produced in England was exported to foreign countries, and one-fourth of this half was despatched to the United States, in all about 750,000 tons. In the year 1874, however, the States only took 130,000 tons, and it was stated that during the three years the producing power of that country had risen from two-and-a-half millions to four millions of tons. Mr. Bell entered into considerable details on the subject of methods of transport in the United States. The railway system has grown into dimensions far exceeding those in England, the land of its birth. At the end of 1873 the United States had 70,651 miles of road, against only 16,082 miles in England. He calculates that 46,000 acres of timber fall annually to provide fuel for the charcoal furnaces. Less than 200 acres of a four-feet seam of coal, in the county of Durham, would produce the same weight of coke as is obtained from 46,000 acres of American forest. Coal is more abundant in the United States than in any other part of the world, and all kinds are found. In some places natural gas is used for puddling, re-heating, &c. Of pit-coal itself there are 192,000 square miles, as compared with 8,000 square miles in the United Kingdom; and Mr. Bell thinks it may be doubted where there is any similar area in the world in which a larger proportion of the surface is occupied by coal-bearing strata. From the position which the beds of anthracite coal occupy, it would appear as if, after their original formation, an enormous amount of lateral compression had been experienced by the districts in which they lie. This force has raised the strata into a succession of waves, as it were, the slopes of which vary from an angle of 20 to 45 degrees, and occasionally descending to a depth of 200 to 250 fathoms or more. In some cases this compressive power has been so great as to have forced one ridge back over its neighbour, to such an extent as to convert what is the floor of the seam in one place into the roof at another, and, from a similar cause, the quantity of coal which has accumulated at the anticlinal axes of some of these coal undulations is so great as to afford a face of forty to sixty feet, or even more, in thickness. In some cases denudation has carried off not only the sandstones and shales, but a portion of the coal itself; the bared edge of the seam is found immediately under the alluvial matter of the surface. He stated that there is a vast extent of carboniferous or mountain limestone in America, frequently very near the pig-iron works. Near Baltimore the shells of oysters, which are found in great abundance at Chesapeake Bay, are used. They contain 95 per cent. of carbonate of lime, and are a very inexpensive substitute for lime itself. The United States contains abundant quantities of iron ore of all kinds except the spathose ore, which is very scarce even in Europe. The ironstone of the liassic and oolitic seams, which furnish about one-third of the pig-iron made in the United Kingdom, seems to be entirely wanting in the States. Mr. Bell described the magnetic iron ore of Lake Champlain, its peculiarities, mode of deposition, &c., its abundance, and its freedom from deleterious ingredients; he remarked that the contents of the mines are chiefly obtained by open quarry work. The ore yields something like 67 per cent. in the Iron Mountain deposit. Mr. Bell, in treating of the blast-furnaces, referred first to the establishments which have been founded for promoting scientific training and education, and he spoke very highly of the earnestness and devotion which characterises those engaged in the mining and metallurgical industries of the States.

At Friday's meeting Mr. Bell read a paper on "The Sum of Heat utilised in smelting Cleveland Ironstone."

Other papers read on Friday were: "A brief account of an Underground Fire in the Wynnstay Colliery, Ruabon, and the measures adopted to extinguish it and to re-enter the workings," by Mr. G. Thomson. The fire became so unmanageable as to necessitate the sealing up of the shafts, after which explosions of gas took place, and the shafts were resealed, and so remained for a period in all of nearly five months. Preparations were then made for re-entering the mines, and this was successfully accomplished, and, after subsequent difficulties of a varied character had been overcome, the colliery resumed operations after a cessation of about seven months, and were now in full work again. The means used to effect the object, and a detailed explanation of all the operations, together with statistics of the temperature, the pressure, and the composition of the gases in the different shafts from time to time, were given in the paper.

On "The Manufacture of Bessemer Steel in Belgium," by M. Julien Deby, C.E., Brussels, and on "The Howard Boiler," by Mr. David Joy, of Barrow-in-Furness.

Altogether the meeting has been a satisfactory one.

THE PROGRESS OF THE TELEGRAPH*

V.

WE now continue our description of Wheatstone's electrical "Jacquard."

The rapid sequence of currents passed into the line-wire by the "Transmitter" are automatically recorded at the distant station by means of an apparatus called the "Receiver," or printer, which marks upon a continuous paper ribbon, as it passes through the instrument, the "dot" and "dash" code of the Morse alphabet, corresponding to the holes in the perforated Jacquard ribbon, as rapidly as the sequence of currents can be passed into the line. Two forms of this receiving instrument may be noticed: one shown in Fig. 22, in which the "dot" and "dash" code is represented by dots upon the paper ribbon upon either side of a central line, the lower line of dots being read as "dashes" and the upper line as "dots." The paper ribbon, mechanically advanced forward through the machine in a continuous manner, is passed under a shallow dish containing ink or other marking fluid. Two fine small holes are made through the bottom of this reservoir, in a position to correspond with the dots to be printed upon the ribbon as it passes underneath the reservoir. By reason of capillary attraction, the ink is prevented from passing through these apertures. Two electro-magnets, one on either side of the ink-reservoir, actuate two needles, which are adjusted so as to be depressed by the action of the current, and, dipping into the reservoir, pass into the holes, and carry a small dot of ink through on to the paper ribbon; thus the mark is printed as a "dot" or "dash," according as the respective needle is depressed without any friction or mechanical resistance beyond that of the needle dipping into the ink held in the capillary tubes. The electro-magnet coils are so arranged that only the respective needles are acted upon by the currents as they flow from the positive or negative poles of the battery. The "dot" printing is shown at Fig. 23.

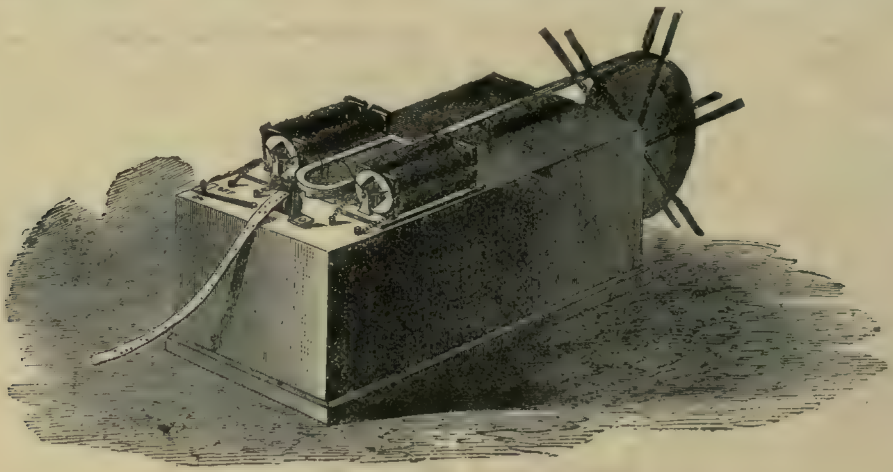

FIG. 22.—Wheatstone's "dot" automatic "Printer."

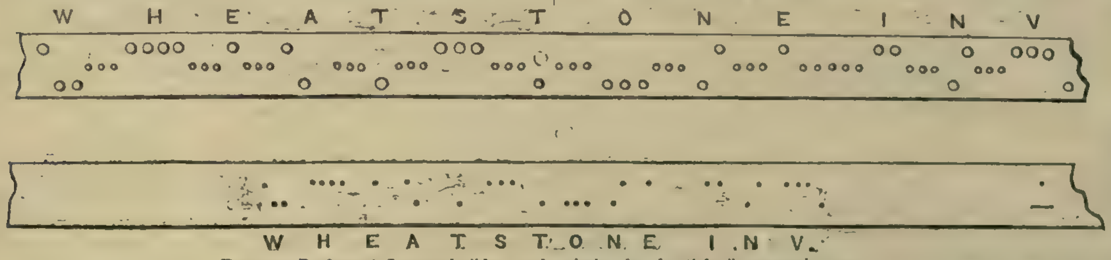

FIG. 23.—Perforated Jacquard ribbon and printing by the "dot" automatic system.

In the other form of "Printer" the Morse code is printed in "dot" and "dash" characters, the groups and sequence of groups forming the letters and words exactly corresponding with the dot and dash perforations in the Jacquard ribbon. Fig. 24 is the automatic printing upon this system from the perforated ribbon shown at Fig. 20. Capillary attraction is here again made use of, only in a different manner. A small inking disc of metal mounted upon a delicately poised axle capable of a slight angular oscillation in a lateral direction, according as it is influenced by the to-and-fro motion of a permanent magnetic armature when acted upon by the alternate currents passed into the line from the "Transmitter," is made to rotate rapidly by the same mechanical means that advances the paper ribbon. This little rotating inker is placed close to the surface of the paper ribbon, so that on receiving a lateral motion in one direction its edge is pressed against the paper and removed from it by an

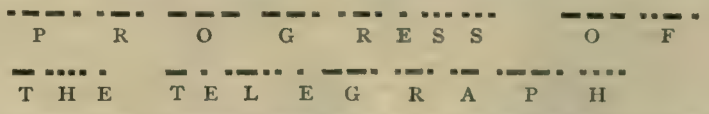

FIG. 24.—An "electric loom," or automatic telegraph printed message from the perforated paper ribbon (Fig. 20.)

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* Continued from vol. xi. p. 512.

opposite motion, while in its neutral position it is free from contact. Thus contact with the paper will produce marks, either dot or dash, according as the inking contact is either momentary or of a sensible duration; the contrary movement producing the spacing between the printed marks. Now, as the currents from the Jacquard ribbon (Fig. 20) are passed at equal intervals and in alternate directions, the spacings between the signals will be automatically regular; the "dash" being the effect of the retention of the magnetic armature acting on the inking disc for double the time of the "dot", by reason of the grouping of the perforations to form the "dash," giving a longer duration without a reversal of the current being passed into the circuit. The arrangement for supplying ink to the little revolving inking disc is simple and effective. A metal wheel, having its edge cut into a V shape, is kept revolving in a dish of ink, and by capillary attraction this V groove is kept constantly filled with ink, and thus the periphery of the little inking disc which revolves in this groove of ink is without any rubbing friction kept constantly supplied with the proper amount of ink to continuously record the rapid motion of the armature as the currents flow from the transmitter into the wire. It is by these very simple means that Wheatstone has produced his high-speed printer, at once an accurate recorder and a telegraphic necessity in these days of special press-transmissions to the chief commercial centres of the United Kingdom.

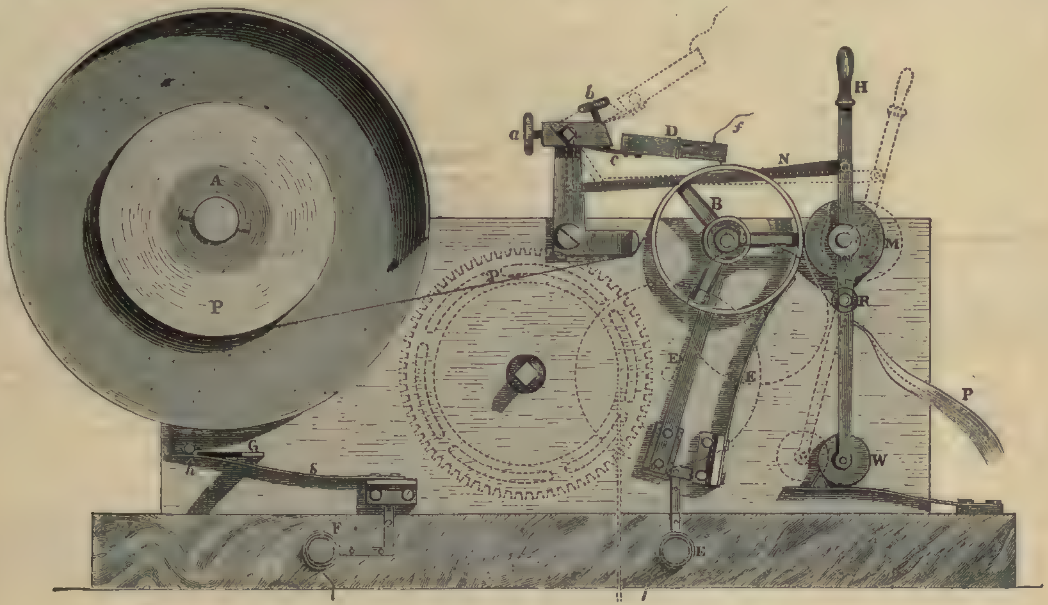

FIG. 25.—Alexander Bain's Automatic Chemical Printing Telegraph, 1846.

In order to realise the great value of the automatic high-speed system upon extended lines of telegraphic transmissions, it is only necessary to compare the speed of the Morse apparatus on lines of a given length with that of the automatic electric Jacquard weaver. With an apparatus combining such celerity of transmission and recording powers, it becomes necessary to adopt a special system for the despatch and receipt of intelligence; to economise manual labour, and utilise the capacity of the wire to the greatest extent. Messages are therefore passed into the machine for transmission along the wire in groups; that is to say, on a circuit of 300 miles in length, twelve messages will be perforated upon a continuous ribbon and sent through the "transmitter" at the same time, and *vice versâ*. Employing a wire of a capacity known as No. 8 Birmingham wire gauge over this distance, four distinct groups consisting of twelve messages of thirty words each can be forwarded, and three similar groups received, in an hour; equivalent to eighty-four messages of thirty words each, and with the average of five letters to a word, a total of 12,600 letters, or an average of 210 letters per minute, equivalent to forty-two words per minute, with all the necessary formalities and acknowledgments in addition. Such a speed may be maintained in moderately fine weather, and requires a staff of five clerks at both the receiving and transmitting stations; namely, two for perforating the messages on to the paper ribbon, two for writing or translating, and one for the working of the apparatus in sending acknowledgments and signals for repetitions, &c. When dealing with parliamentary and newspaper despatches, a much higher speed can be obtained, first because there is no necessity for grouping the messages, and secondly because, as a rule, the transmissions are only in one direction, either as wholly received or forwarded messages, which circumstances greatly reduce the initial delay in the transmission. With a No. 4 wire gauge between Aberdeen and London, forty words may be reached, and with a No. 6 wire between Edinburgh and London fifty words, between Newcastle-upon-Tyne and London sixty words, and between Glasgow and Liverpool 120 words may be recorded. The shorter the length of the line, the greater the speed obtained. A very rapid form of a chemical automatic printing telegraph has been designed in America, based upon Alexander Bain's chemical automatic printer, 1846. This American chemical automatic machine has sent and printed, under favourable conditions, intelligence between Washington and New York, a distance of 282 miles, at a speed of 1,050 words or about 5,250 letters per minute, at which rate the apparatus required ten perforators, thirteen copyists, and two instrument-operators to keep the circuit supplied and the transmissions transcribed for general circulation. How far such a speed can be profitably employed for telegraphic purposes remains to be developed. It is quite possible to transmit intelligence beyond a profitable speed, for, irrespective of the difficulty of always commanding a sufficient amount of intelligence to keep the apparatus fully employed, the vast staff of manipulators necessary to ensure the preparation of the Jacquard ribbon, and translation of the symbolic code into language, must always form a very important element in the commercial value of all high-speed arrangements, when the speed is beyond that of the public requirements of the circuit.

Alexander Bain's chemical printing telegraph, invented in 1846, of which this American automatic machine is only a modernised adaptation, is shown at Fig. 25. It combined methods of arranging, transmitting, and receiving electrical telegraph communications, in which mechanically-composed communications were transmitted through electric circuits, and received by chemically prepared surfaces, both apparatus being kept in motion by mechanical means, without the aid of magnets. The apparatus consisted of a frame containing a driving power by which a rotatory motion was imparted to the metal drum B, placed in connection with the earth by means of the contact springs E E. The paper strip P P, chemically prepared by being immersed in a solution of sulphuric acid and prussiate of potass to receive the sequence of currents transmitted through the wire from the "transmitter," is wound upon the drum A, and is drawn forward over the revolving earth contact B at a uniform speed by reason of the pressure of the break roller M, which may, whenever the paper is not required to advance, be withdrawn by the lever H working on the centre R, and kept in position either way by the action of the spring roller W. An insulated metallic style D, in connection with the line wire *f*, and furnished with the necessary screw adjustments *a*, *b*, *c*, is arranged to press uniformly upon the chemically-prepared paper as it passes over the earth drum B. The style D can also be removed from pressing contact with the paper ribbon when required, as indicated by the dotted outline. When therefore the style D is passing over the surface of the prepared paper, and electric currents are passed through the line wire *f* from the distant station, the electric circuit will be completed through the paper ribbon P, and the metallic drum B, with the earth E, and in the passage of the current, the iron in the chemical solution is decomposed and a dark blue mark becomes visible upon the paper corresponding in length to the duration of the current; so that if the Jacquard ribbon at the distant station is perforated into the necessary length of holes to represent the sequences of dots and dashes in the Morse code, to form letters and words, the chemical decomposition from the style D will be an accurate replica of the distant message in the "dot" and "dash" symbols. It was thus that in 1846 Alexander Bain, the clever and ingenious Edinburgh watchmaker, originated a system of electric automatic chemical Jacquard printing, which even at the present day is scarcely understood, and which in all probability is left to American skill to develop. Its extreme simplicity and wonderful chemical sensibility speak volumes in its favour, provided, as has been already observed, such extreme velocities can be profitably worked in this small planet of ours.

(*To be continued.*)

RECENT FRENCH MATHEMATICAL PUBLICATIONS

M. CHASLES is reprinting a new edition of his celebrated work, "Aperçu Historique:" the first part has been already issued. The learned geometer has made no alteration in the book, which was written many years ago and long before he had been led to assert frivolous claims in favour of Pascal, and no allusion is made to the Newton forgeries. The whole work will cost no more than 20*s.*, only one-fourth of the selling price of the old edition, which has for some time been very scarce.

There has been in France a revival of interest in the subject of imaginary quantities. Thus, a translation by Laisant of Bellavitis's "Calcul des Equipollences" has been published lately. It is regarded by Bellavitis himself as a system of quaternions in one plane, and thus is somewhat analogous to the efforts made in England to popularise the great Hamilton's theories. But it is only a partial effort, as Bellavitis's results do not admit of being generalised so as to apply to solid geometry.

M. Hoüel, whose name is connected with the publication of a series of useful tables, will very likely be more successful in this respect, as he is preparing a "Theory of Quaternions."

The same mathematician has edited a reprint of a work on the "Geometrical Representation of Imaginary Quantities," originally published in 1806 by Argand. One of his objects appears to have been to defend the rights of his illustrious countryman. But they are not so disregarded in England as the author seems to suppose.

The third and concluding part of the new edition of Briot and Bouquet's "Theory of Elliptic Functions" has appeared. It is quite a new book, though professing to be a second edition of the small octavo volume which became rapidly so popular amongst mathematicians.

M. Paul de Saint Robert has published a third and concluding volume of his interesting "Memoirs," several of which were published in English in the *Philosophical Magazine.* Amongst these valuable papers, which are here reprinted, we must not neglect to notice the "New formulæ for determining the altitude from barometric observations." These formulæ embody the results of the observations taken by Mr. James Glaisher in some of his aëronautical ascents. M. Saint Robert in this way improves the well-known Laplace's formulæ, which were based only on the Ramont's observations taken in the Pyrenean ranges; and takes into account the carefully observed facts which had been neglected in England.

NOTES

THE Committee on the Loan Exhibition of Scientific Apparatus met in the Science Schools at the South Kensington Museum yesterday. It has been determined to postpone the exhibition till March 1876, and from the strength of the Committee appointed and the interest taken in the scheme by scientific societies, we may expect the collection to be unique.

IT will be of interest to geologists to know that Capt. Feilden, R.A., the naturalist of the senior ship of the Arctic Expedition, in addition to making the observations on the birds of Northern Europe, Malta, India, China, and North America, which will be found scattered through the pages of the "Zoologist" and quoted by Prof. Newton and Messrs. Sharpe and Dresser in various works, has given much attention to the palæontology of many of these countries, especially to the Miocenes of Malta and the Faroe islands, and the Mastodon beds of South Carolina. By permission of Prof. Ramsay, V.P.R.S., the Director-General of H.M. Geological Survey, Capt. Feilden has also recently been shown the method employed in carrying out geological field-work by that Survey, by one of its staff, Mr. De Rance.

THE French Academy of Sciences, at its sitting on Monday last, received the report of M. Fleuriais, the head of the Transit of Venus Expedition to Pekin. The observations were very satisfactory indeed, the four contacts having been photographed with complete success. The weather was very boisterous all the day long, but at the four important moments the observers were favoured by a total absence of clouds. They succeeded in executing a map of Pekin, in spite of the obstacles placed in their way by the natives. The dimensions are 8,000 metres by 7,000, and the length of the walls is 33 kilometres. The instruments set up by the missionaries last century are in perfect order. The instruments sent by the Academy to China are to remain there, and perhaps a permanent observatory may be established.

PROF. JAMES DEWAR, in resigning his post of Chemist to the Highland Agricultural Society, on his appointment to the Jacksonian Chair, Cambridge, has told that Society some wholesome truths, which we hope they will take to heart. Mr. Dewar writes:—"After what has occurred, it will hardly be necessary for me to say anything about what might have been had the chemical department been rearranged in the way I naturally anticipated after the death of Dr. Anderson. You are aware I intended prosecuting investigations in vegetable physiology, had the proper means been placed at my disposal; and the desire to do so was the main reason of my leaving the University. As it seems, however, the opinion of a portion of the Society that an agricultural chemist (so-called by the uninitiated, because his business is chemical analyses and the manipulating of the farming interests) rather than a scientific chemist would be best qualified to discharge the duties of the office of chemist, I have considered it my duty to accept the Cambridge Professorship as the best means of getting out of a false position. I still trust, however, the Society will ultimately see that this office of chemist will never be properly filled except by one thoroughly trained in scientific research, and this, the making him a real agricultural chemist, will depend on the means placed at his disposal for applying his scientific knowledge to agriculture."

WE are glad to see that the University of Glasgow is doing what it can to promote experimental investigation among its students; for this purpose the following two prizes are offered:—1. In Natural Philosophy, the Cleland Gold Medal, for the best "Experimental Determination of Magnetic Moments in Absolute Measure." All students of the Natural Philosophy Class in Session 1874–75, or Session 1875–76, may be competitors. 2. The Watt Prizes of 10*l.* for the best "Numerical, Graphic, and Experimental Illustrations of Fourier's Solutions of Problems in Thermal Conduction." Cooling of a cylinder to be worked out *numerically* in one or more cases: cooling of a globe may be illustrated *experimentally* in one or more cases. All matriculated students of the University in Session 1875–76, who have finished, or who on the 1st day of May, 1876, shall finish a regular course of Languages and Philosophy, may be competitors. Two or more competitors for the prize may work together and give in a joint essay; and two prizes will be given in case of sufficient merit. The Physical Laboratory of the University will afford the requisite experimental means for candidates for the Watt and Cleland Prizes. When will Oxford and Cambridge follow such a good example?

IT is with great regret that we record the death, in his fifty-fourth year, of Admiral Sherard Osborn, C.B., F.R.S., which took place suddenly on Thursday night last. Admiral Osborn's name is well known in connection with Arctic exploration, and he was to have read a paper last Monday on the Arctic Expedition before the Royal Geographical Society. He was born April 25, 1822, entered the navy in 1837, and served in the East Indies and in China. He obtained his commission as lieutenant in 1846, and three years later was selected as a volunteer for the Arctic Expedition, under Capt. H. T. Austen, sent in search of Sir John Franklin, being appointed to command the *Pioneer*. He afterwards served with distinction during the Russian war, in China, and in Mexico. In 1864 Capt. Osborn was appointed to the command of the turret-ship *Royal Sovereign*, and was afterwards for several years managing director of the Great Indian Peninsular Railway at Bombay. Admiral Osborn naturally took a keen interest in the Arctic Expedition which is so soon to leave our shores.

THE following naturalists have been elected foreign members of the Linnean Society of London, viz.: Alexander Agassiz, H. E. Baillon, Ferdinand Cohn, M.D., A. de Quatrefages, and F. Parlatore.

DR. G. J. Allman, F.R.S., has been elected Examiner in Zoology, and Dr. M. T. Masters, F.R.S., Examiner in Botany to the University of London.

AN outline of the lectures on the Invertebrata being delivered at Edinburgh University by Prof. Huxley is being published in the *Medical Times and Gazette*; the first instalment appeared in last Saturday's number.

OUR readers are familiar with the name of the Penikese School of Zoology in the United States, and last week we gave the programme of a similar institution for the practical study of Geology. The faculty of Harvard College are, we believe, arranging for similar schools for other branches of scientific instruction, and have announced three separate courses, besides the one on Geology:—One of Chemistry, under Prof. J. P. Cook, to be held at Cambridge. The second is a course in Phenogamic Botany, to be given in the Botanical Laboratory at Cambridge, by Prof. Goodale. The Botanical Garden and Herbarium will furnish material for instruction in Structural and Systematic Botany. All necessary appliances, including dissecting and compound microscopes, will be furnished by the instructor. The third course is that of Cryptogamic Botany, under Prof. W. G. Farlow. This course will be held at some point on the sea-shore, possibly Provincetown or other suitable locality, and in this respect will correspond to the plan of the summer school of zoology at Penikese. Twelve lectures will be devoted to the Algæ and six to the Fungi. A laboratory will be established, and excursions will be made throughout the course by the students in company with Prof. Farlow.

FROM Baron Mueller, Government Botanist of Victoria, Australia, we have received his last report of the progress and condition of botany in that colony. From a scientific point of view, and equally in regard to the advance of applied botany, it contains many interesting particulars. The learned writer, who has done so much to promote the development of the vegetable resources of Australia, laments the withdrawal of the working votes of his department, and his removal from the directorship of the Botanic Garden, as he is thereby deprived of the means of conducting his researches. We glean the following notes from this report. The vegetation (exclusive of some of the lower cryptogams) of the whole of Australia is estimated at 11,000 species. The number of grasses is about 250 species. Numerous experiments have been made to ascertain the quality and practical working of various fibres, oils, tars, acetic acid, gums, resins, starch, potash, paper materials, dyes, &c., obtained from native and introduced plants, a complete list of which is appended to the report. In some experiments on rabbits with the tubers of *Burchardia umbellata* and *Anguillaria australis*, it was ascertained that although belonging to a doubtful family, they contain no noxious principle. In the search for jalap in the tubers of indigenous terrestrial orchids, the common *Microtis porrifolia* gave the best and highly satisfactory results. In drying, the roots of this species evolve a slight violet odour, and ten grains of the dry powder produces one ounce of good pale mucilage, free from bitterness. The tubers of *Thelymitra aristata*, although still richer in mucilage, are slightly bitter and of a brownish tinge. Very much has been effected in the distribution of the seeds of the gum trees (*Eucalyptus*), of which there are 140 species in Australia, and intesting the qualities of the numerous products of these valuable trees. In a trip to the forest regions of the Upper Yarra last year, Baron Mueller measured some trees of *Eucalyptus amygdalina*, var. *regnans*, which were approximately 400 feet in height. The magnificent grass *Festuca dives* was found in the same region growing to a height of 17 feet on the borders of rivulets. For educational purposes in the colonial schools, 100 sets of native plants have been dried and mounted, each set containing fifty species. Since the publication of the last report about fifty new genera have been added to the flora of Australia, including many of great interest in phyto-geography. Thus the genera *Corynocarpus* and *Carmichaelia*, previously only known from New Zealand, have been discovered in Australia. A species of *Ilex* (holly) has also been found, and an elm belonging to the section *Microptelea*. About fifteen of the genera are absolutely new to science.

THE excellent collection of Madeira plants formed by the late Rev. Mr. Lowe, who, with Mrs. Lowe, was lost last year in the wreck of the *Liberia*, was deposited in the Herbarium at Kew some months since, and is, we understand, to be divided between the British Museum and the establishment named, the latter taking the *uniques*. It is fortunate that so valuable a collection has become public property, as it contains the types of the lamented gentleman's new species, and specimens of many things that are now exceedingly rare in the islands. In private hands it might have been neglected, and certainly would have been inaccessible to most botanists.

IN the appendix to the United States Coast Survey Report for 1872, now in the press, is a report by Mr. W. H. Dall on the tides, currents, and meteorology of the Eastern Aleutian region and the North-east Pacific, accompanied by explanatory diagrams. Mr. Dall's observations on the oceanic currents, which are here tabulated and discussed up to the date of the report, are of special interest as being the first series undertaken with a direct view to the solution of the problems in question, and result in the proof of the existence of a reflexed northerly arm of the great easterly North Pacific current, denominated by him the Alaska current, which had previously been surmised from isolated observations and theoretical considerations. Mr. Dall has been enabled to determine the rate and dimensions of several portions of this current, and maximum, minimum, and mean annual temperature. The existence of definite oceanic currents in the eastern half of Behring Sea is shown to be very doubtful. Some important generalisations on the relations of the Pacific and Behring Sea tides to each other are made, and the peculiarities of the compound tides of this region are graphically indicated by diagrams in a new method, original with the author, and possessing some interest for those studying these problems. The report is accompanied by numerous hydrographic memoranda and tables of meteorological, current, and tidal observations.

THE figure to the letter in last week's NATURE (p. 7), signed X, "On the rôle of feet in the struggle for existence," does not quite illustrate the author's meaning. He intended to draw the same footprint in both cases, but in the case shown in the cut on the left, each footprint should be advanced straight forward in the line of the previous one, while in the other it should be advanced obliquely, leaving a large part of the outline of the previous one clearly marked.

A MEETING was held on Monday last in the theatre of the Royal Institution, Mr. A. J. Mundella, M.P., in the chair, for the purpose of considering the best mode of extending to London the benefits of the Cambridge University Extension Scheme, at which the following gentlemen, among others, were present:—Sir J. Lubbock, Bart., M.P., Dr. L. Playfair, M.P., Dr. W. B. Carpenter, F.R.S., Dr. J. H. Gladstone, F.R.S., Sir H. Cole, C.B., Mr. S. Morley, M.P., Prof. Fawcett, M.P., Mr. T. Hughes, Q.C., Hon. G. Brodrick, Rev. W. Rogers, Mr. H. C. Sorby, F.R.S., and Mr. Jas. Stuart. After Mr. Stuart and Mr. Sorby had explained the object of the meeting, the following resolution was carried:—"That this meeting, having heard Mr. Stuart's statement, considers it desirable to introduce into London the Cambridge University Extension Scheme." A provisional committee was appointed to carry out the objects of the meeting, consisting of Mr. S. Morley, Mr. Mundella, Mr. Jas. Stuart, Rev. W. Rogers, Mr. T. Hughes, Mr. R. N. Phillips, Dr. Carpenter, Mr. W. L. Birkbeck, Mr. H. C. Sorby, and Mr. G. M. Norris.

THE regular annual meeting of the U.S. National Academy of Science took place at the Smithsonian Institution in Washington on the 20th of April, and continued three days. The attendance was about the same as usual, there being some twenty-five members present out of the seventy-five. Numerous papers of much scientific interest were brought forward. In accordance with the rules of the Academy, five new members were elected. These are: Prof. R. E. Rogers, Professor of Chemistry of the University of Pennsylvania; Prof. Asaph Hall, one of the astronomers at the Washington Observatory; Prof. Alpheus Hyatt, curator of the Natural History Society of Boston; Prof. Joseph Le Conte, of the University of California; and Mr. Lewis H. Morgan, of Rochester. All these gentlemen are eminent in their respective branches of science, and constitute a valuable addition to the membership of the Academy, which now embraces about eighty individuals, selected from the representative men of science throughout the United States. The only loss which the Academy has experienced by death during the year is, as stated by the president, that of Prof. Jeffries Wyman.

SIR CHARLES REED, as a member of the Gresham Committee, writes to the *Times*, giving the arrangements which have been made for the future conduct of the Gresham Lectures. The lectures are not in future to be delivered in the Latin tongue. The times of delivery are to be fixed, not by the lecturers, but by the Committee. The lecturers are required to deliver their own lectures, and the nomination of a substitute is allowed only in case of illness. The appointment of the lecturer is for one year, securing to the Committee an opportunity of annual revision. It will be seen that the Committee have taken a step in the right direction, and we hope that it is only the first step to a radical reform.

A scientific Society has been formed in Bedford, under the title of the Bedfordshire Natural History Society and Field Club.

IN reference to Mr. Fordham's letter in last week's NATURE, in which he states that in his part of the country the cowslip is very abundant but the primrose is not found, Mr. J. J. Murphy asks, what part of the country Mr. Fordham means? The opposite is true at Dunmurry, Co. Antrim, where there is plenty of primroses, but few if any cowslips.

WE are glad to see that at the great International Exhibition to be opened at Philadelphia next year, a Department (VII.) is to be devoted to "Apparatus and Methods for the Increase and Diffusion of Knowledge." The following are the groups into which the department is divided:—Educational apparatus and methods. Typographic aids to the preservation and dissemination of knowledge, books, periodicals, newspapers. Charts, maps, and graphic representations. Telegraphic instruments and methods. Instruments of precision, and apparatus of physical research, experiment, and illustration. Meteorological instruments and apparatus. Mechanical calculation—indicating and registering apparatus, other than meteorological. Weights, weighing, and meteorological apparatus—measures and coins. Chronometric apparatus—time-keepers of all kinds, watches, clocks, &c. Musical instruments and acoustic apparatus. Under Department X. also there are two groups which might be classed along with these:—Education: illustration of the various systems and accessories of education, from the infant school to the University, including special schools of science and art, libraries, &c. Institutions, Societies, and Organisations having for their object the Promotion of Science: illustrations of the rise, progress, and results of the various organisations for the promotion of science; models, drawings, descriptions, and statistics.

MR. STANFORD has just published a North Polar map, superior in most respects to anything we have seen. It embraces a circle of forty degrees from the pole, thus including the whole of England. It exhibits faithfully all the circumpolar lands hitherto discovered, and in bold red letters shows the points reached by all the most important discoverers, with the date of discovery, from Sebastian Cabot down to Payer and Weyprecht; even the spot where it is hoped that H.M.S. *Discovery* will winter is indicated. By means of dark and light blue, the usual limits of the ice and open water are clearly shown, and the whole execution of the map reflects the greatest credit on Mr. Stanford's establishment.

WE have seen an ingenious scientific apparatus which entirely obviates the use of matches or tapers, and does away with the attendant danger in lighting gas. It consists of a small bichromate of potash battery, the zinc plate of which is so arranged that by the pressure of the finger it can be immersed in the exciting fluid and put the battery in action. Rising from the top of the battery is a light brass stem, like a taper-holder, but in the form of a swan's neck, terminating in a little bell, within which the two "poles" of the battery are united by a spiral of platinum wire; this wire, when the battery is put in action by the immersion of the zinc plate, becomes white hot, and will instantly ignite the gas if held over the open burner. The name which the maker, Mr. Horatio Yeates, has given to this happy contrivance is the "Galvano-Pyreon, or Voltaic Gas-lighter."

M. ELIE DE BEAUMONT left a library containing a number of valuable scientific books, which his nephew and heir has presented to the Geological Survey of France, of which his uncle was Director. The grant includes more than 2,000 volumes relating to geology, and 600 maps.

WE formerly mentioned that the widow of the late General Poncelet founded a few years ago a prize to be awarded by the Institute. It was a handsome sum of money to be given every two or three years to the author of the best essay on Mechanics. Last week Madame Poncelet sent to the Academy a large number of copies of the *Œuvres Complètes* of her husband, which were completed only last month, with the request that each successful competitor for the Poncelet Prize should be presented with a copy. But as the stock would be exhausted in the course of five or six centuries, the careful widow has created a special accumulating fund providing for a new edition in the year 2600 A.D.

THE Paris Acclimatisation Society held its anniversary meeting on the 6th of May, under the presidency of M. Drouyn de Lhuys. M. Pichot gave a long and interesting address on acclimatisation in Egypt under the Pharaohs. Many prizes were awarded for practical results obtained in the way of introducing new kinds of animals into France. One of these was given by M. Joseph Cornely, for having succeeded in the multiplication of the kangaroos left in a state of liberty.

THE additions to the Zoological Society's Gardens during the past week include a Guinea Baboon (*Cynocephalus sphinx*) from West Africa, presented by Mr. Lionel Hart; a Yellow-shouldered Amazon (*Chrysotis ochroptera*) from South America, presented by Miss M. Sutherland; a Molucca Deer (*Cervus moluccensis*), a Pampas Deer (*Cervus campestris*), born in the Gardens; two Chinese Jay-Thrushes (*Garrulax chinensis*) from China, purchased; a Patas Monkey (*Cercopithecus ruber*) from West Africa; a Hairy Tree Porcupine (*Cercolabes rupestris*), a Rock Cavy (*Cerodon rupestris*) from Brazil, deposited.

NATURAL HISTORY OF KERGUELEN'S ISLAND *

IT is difficult, owing to the inexactness of the charts, to inform you of the positions of the Astronomical Stations in whose neighbourhood I have been able to work in this island. The German station is in Betsy Cove, the American at Molloy Point, Royal Sound. The English stations also are in this Sound, the second being situated about three miles N. by W. of Swain's Haulover. The first English station is between these last two on the main land, six or seven miles N.W. of Three Island Harbour, in what will be called Observatory Bay. Two days before the Transit of Venus a party under Lieut. Goodridge, R.N., was detached from the first English station to observe the transit from a position which he selected near the base of Thumb Peak. I have not yet been able to visit Betsy Cove.

Observatory Bay is one of the minor inlets of a peninsula comprised between two narrow arms of the sea. One of these runs up from the Sound, along the western flank of the hills adjacent to Mount Crozier, several miles, and terminates at a distance of three or four hours to the north of us, and about four miles from the inlet near Vulcan Cove. The other arm, opening nine or ten miles away to the southward, proceeds in a north-easterly direction to within three or four miles of the former, and no great distance from Foundry Branch.

Besides the inlets of the sea, numerous freshwater lakes present obstacles to inland travelling. Some in this neighbourhood are two or three miles in length, but in general they are not more than a mile long. They are usually shallow, and appear to be uninhabited by fish. The bogs and streams in this vicinity are not impassable, but can be traversed with ease if ordinary care be taken.

The most salient features of the landscape are the basaltic hills, with irregular terraces of rock on their sides, and broken cliffs at their summits. In lieu of grass, their slopes are clothed with banks and boulder-like clumps of *Azorella selago*, excepting where rich damp loam affords a soil suitable for the *Acæna* and the *Pringlea*. Here and there a fern (*Lomaria*) and grass (*Festuca*) grow in the interspaces of the other plants.

The climate of Royal Sound is far warmer and drier than we were led to expect it would be. In November the weather was very pleasant; since then it has deteriorated, though the snow has not again covered the ground as it did when we first arrived. Probably the previous accounts of its meteorology were based upon observations taken in parts of the island where bad weather prevails; or it may be that the condition of the country in winter has been presumed to be constant throughout the year. In one respect we were rightly informed; for usually when there is no breeze there is a gale. A calm day is an exceptional event. Meteorological observations are being taken in Observatory Bay on board the *Volage* and by the sappers on shore.

Corresponding with the unlooked-for superiority in climate, a difference is noticeable in the vegetation of this part of the island. Some plants which occur at both extremities of the country display in Royal Sound marks of luxuriance. For instance, *Pringlea antiscorbutica*, which is elsewhere apetalous, here in sheltered places frequently develops petals; some flowers in the same inflorescence possessing one petal only, others having two, three, or four. And the petals are not always of a pale greenish colour, but occasionally are tinged with purple. Again, *Lomaria alpina*, which is mentioned in the flora as rare in the neighbourhood of Christmas Harbour, is excessively common and very finely grown here. There are also more species of flowering plants and of the higher orders of Cryptogamia here than were found by the Antarctic Expedition at the north of the island. But there are fewer species of mosses, lichens, and algæ. Their paucity, in comparison with those of the other district, is probably due to the nature of the rocks on land, and to the seclusion of the bay from the open sea. The additions to the flora are for the most part Falkland Islands species.

In speaking of the climate, it may be mentioned that the plants of Kerguelen's Island are not (as was supposed) in flower throughout the year; but probably some of them do not cease flowering until late in the winter. When we first arrived in Royal Sound the ground was covered with snow, and scarcely anything had begun to come out. The *Pringlea* was far advanced in bud, barely commencing to blossom. The *Acæna* was just beginning to burst into leaf. About the first week in November *Festuca Cookii* came out, and a few days later *Azorella selago*. The young fronds of the ferns were just about to unroll. In the third week of the same month *Montia fontana* and *Acæna affinis* were in flower in a sheltered spot, and *Leptinella plumosa* was first found in blossom. *Galium antarcticum* appeared about the same date. A week later, *Ranunculus hydrophilus* and a *Festuca* (*purpurascens?*) were out, and *Lycopodium clavatum* was sprouting. By the middle of the month *Triodia* and *Lyallia kerguelensis* and also *Ranunculus crassipes* were in flower; the *Pringlea* was everywhere past flowering (excepting upon the mountains), and *Aira antarctica* began to shoot forth its panicles. Before the end of the month a *Carex* came out; but *Bulliarda* and other plants delayed still.

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* "First Report of the Naturalist attached to the Transit of Venus Expedition to Kerguelen's Island, December 1874" By the Rev. E. A. Eaton. Communicated by the President. A letter to the Secretary of the Royal Society, dated Royal Sound, Kerguelen's Island, 31st December, 1874. Read April 8.

A few species of Mammals have been introduced into the island. Mice (evidently *Mus musculus*, L.) are common along the coast, and have been found by us in various places. The rabbits, transported by order of the Admiralty from the convict settlement in Table Bay, have been landed by H.M.S. *Volage* in Royal Sound. They share with the birds holes of the petrels, and are (it is almost superfluous to mention) propagating freely. Their favourite food is the *Acæna;* but they occasionally eat *Pringlea* leaves and gnaw away the green surface of *Azorella*. In the Crozettes, whose climate and flora are said to resemble those of this island, rabbits have become extremely abundant, and so rank and coarse that the sealers will not eat them. Goats are increasing in numbers on the leeward side of the main land.

Whales and porpoises occasionally enter the Sound. Old skulls of the latter, wanting the lower jaw, are cast up here and there on the beaches.

Up to the present time I have captured only two species of seals—a female sea leopard and two males of a Platyrhine Seal. The other kinds frequent the more open parts of the coast and islands.

Twenty-two species of birds, at the fewest, perhaps twenty-three, frequent Royal Sound, viz., a *Chionis*, a Cormorant, a Teal, a Tern, a Gull, a Skua, eleven (perhaps twelve) Petrels, two Albatrosses, and three (perhaps four) Penguins. Of these, I have procured eggs of the first six; also of six Petrels, one Albatross, and two Penguins. The *Thalassidromæ* are preparing for laying.

Fish are rather scarce in Observatory Bay. Only three species have hitherto occurred to us, two of which are common under stones at low water. The remains of a *Raia* have also been picked up on one of the islands by an officer of the *Volage*, but hardly sufficient is left to enable the species to be determined. It is allied to *R. clavata* and *R. radiata*.

The entomology of the island is very interesting. Most of the larger insects seem to be incapable of flight. I have found representatives of the orders Lepidoptera, Diptera, Coleoptera, and Colembola.

The Lepidoptera comprise a species of the *Noctuina* (as I suppose) and one of the *Tineina*. Of the first I have not yet reared the imago; the larva is a moss eater and subterranean: the adult is probably as large as an *Agrotis* of medium size. The species of *Tineina* is probably one of the *Gelechidæ*, judging from the form of the palpi. Its larva feeds on young shoots of *Festucæ*, and sometimes spins a silken cocoon for the pupa. The imago, of which the sexes are alike, has acute and very abbreviated wings, and the posterior pair extremely minute. In repose the antennæ are widely separated, and almost divaricate. When the sun shines the adult is active, and, if alarmed, jumps to a distance of two or three inches at a time. During its passage through the air the wings are vibrated.

The Diptera are represented by species of the Tipulidæ and Muscidæ. There are three of the former family. One of them is a small species of the Cecidomyidæ, which is abundant in mossy places, and presents no marked peculiarity. Another seems to be a degraded member of the Tipulidæ. The antennæ have six joints, the palpi two; the wings are ligulate and very minute. It possesses halteres, and the female has the ovipositor enclosed in an exposed sheath. Although it is unable to fly, it lives upon rocks in the sea, which are covered at high water, and there it deposits its eggs in tufts of *Enteromorpha*. The third species has full-sized wings: it was caught in the house. The indigenous Muscidæ are very sluggish in their movements, and are incapable of flight. Four species are common about here. One of them is abundant on *Pringlea*, crawling over the leaves. When it is approached it feigns to be dead, and, tucking up its legs, drops down into the axils of the leaves; or, if it happens to be upon a plane surface, one need only look at it closely, and it throws itself promptly upon its back and remains motionless until the threatened danger is over, when it gradually ventures to move its limbs and struggle to regain its footing. Its wings are represented by minute gemmules, and it possesses halteres. The ovipositor is extended, its apical joint alone being retracted. The penis is porrected beneath the abdomen, where it fits into a notch at the apex of the penultimate segment. The larva feeds on decaying vegetable matter. Another species occurs on dead birds and animals, as well as beneath stones near the highest tide-mark. It is completely destitute of even the vestiges of wings and halteres. The sexual organs are concealed. It and the preceding species are rather smooth. A third species, slightly hairy, is common among tide refuse and on the adjacent rocks, which are coated with stunted *Enteromorpha*, on which plant, *inter alia*, the larva feeds. It has very small triangular rudiments of wings, slightly emarginate near the apex of the costa, and possesses halteres. The sexual organs are not exposed. The fourth species occurs amongst grass growing along the shore, and also in Shag rookeries. Its linear and very narrow wings are almost as long as the abdomen. It can jump, but cannot fly. The sexual organs are retracted.

A *Pulex* is parasitic upon *Halidroma*, and one (possibly the same species) on *Diomedea fuliginosa*.

Coleoptera are not uncommon. The larger species seem to have their elytra soldered together. There is a small species of the Brachyelytra.

Several species of *Nirmiidæ* have been obtained.

Two *Poduræ* (one black, the other white) are plentiful.

There appear to be few species of Spiders, though individuals are numerous. Penguins and some of the other birds are infested with Ticks. The remaining Arachnida are related to *Cribates*.

The Crustacea, Annelida, Mollusca, and Echinodermata in this part of the island have probably been collected by the *Challenger* more extensively than I have been able to do; therefore I need not particularise further about them than to state that Entomostraca abound in the lakes; an earthworm is common, and a land-snail is very plentiful amongst the rocks on the hills. This last appears to appreciate comparative heat, for specimens obtained in an exposed place during the frosty weather were assembled together for warmth, under the drip of an icicle.

In Observatory Bay Cœlenterata are not numerous. One or two species of Actiniidæ on the rocks and Macrocystis roots, and an Ilyanthid in mud, are the only Actinozoa I have met with. The Hydrozoa similarly have afforded only three species—a Corynid, a Campanularian, and a *Sertularella*.

There are several Sponges.

With the exception of *Limosella aquatica*, and perhaps *Agrostis antarctica*, I have obtained all the flowering plants and ferns given in the "Flora Antarctica" as indigenous to the island. Besides these, *Ranunculus hydrophilus* and another species, a *Carex*, a *Festuca* (probably *F. purpurascens*, but I have no work containing descriptions of the flowering plants), *Polypodium vulgare*, a fern allied to *Polypodium*, and *Cystopteris fragilis* have occurred to me. There is also a plant which appears to belong to the Juncaceæ. *Lycopodium clavatum* and *L. selago* are common about here. None of the Mosses, Hepaticæ, or Lichens have been worked out as yet; but amongst them are one or two species of *Cladonia*, and some examples of *Lecanora paleacea*. Fungi are represented by *Agaricus* (*Psalliota*) *arvensis*, *Coprinus atramentarius*, and a peculiar parasite on *Azorella*, which grows out from the rosettes in the form of a clear jelly, which becomes changed into a firm yellowish substance of indefinite form. There are also some *Sphæriacei* on grass and dead stems of plants. At present few additions have been made to the marine flora. The larger Algæ in Royal Sound are usually not cast upon the shore by the waves, and I have almost been entirely dependent upon grapples thrown from the rocks for specimens of the more delicate forms. *Polysiphonia Sulivanæ* and *Rhytiphlœa Gomardii* are amongst the novelties. A large number of zoological and botanical specimens have been lost through my inability to attend to them in time without assistance. This has principally affected the number of duplicates; but in one instance it has led to the loss of a species—one of the Petrels, which was the commonest bird about here when we first arrived. Fortunately it is a well-known species.

The 1st of March is announced as the approximate date of our sailing from Kerguelen's Island. Five weeks later I hope to arrive at the Cape and to forward to you such of the specimens collected as require only ordinary care in their transmission. The more fragile things are likely to reach you in better condition if I keep them until my return to England, than they would if they were sent with the others.

SCIENTIFIC SERIALS

Journal de Physique théorique et appliquée, Feb. 1875.—This number contains several papers reprinted from other serials, and the following original ones:—On the spectra of yttrium, erbium, didymium, and lanthanum, by Prof. R. Thalèn. On account of the difficulty to obtain the compounds of these metals in a pure state, considerable doubt has hitherto existed, whether certain lines that always appeared in the spectra of yttrium and ertium and in those of didymium and lanthanum belonged to the first or second metal in the pair; the state of these questions in 1868 was, that there were twelve lines which always appeared when yttrium or erbium were examined, and sixteen lines in the case of didymium and lanthanum. Prof. Thalèn succeeded in obtaining sufficient quantities of compounds of each of the metals, from M. Cleve, Professor of Chemistry at the Upsala University, and these were of undoubted purity. He was thus enabled to study their spectra most accurately, and the following table shows the number of lines found in former and in the recent researches:—

Metal.	Number of lines.		
	1868.		1873.
Yttrium	70	+ 12 uncertain	106
Erbium	10		83
Didymium	6	+ 16 „	209
Lanthanum	49		188

It was found that the twelve uncertain lines that always appeared with yttrium or erbium belong to yttrium only; in the same way the sixteen uncertain ones in the second case belong only to the lanthanum spectrum. Prof. Thalèn gives a detailed map of the spectra in question.—Researches on the induction sparks and electro-magnets; their application to electro-chronographs, by M. Marcel Deprez.—On analogies in the evolution of gases from their over-saturated solutions, and the decomposition of certain explosive substances, by M. D. Gernez.—On the preservation of energy in electric currents, by M. E. Bouty.—On the transformation of static into dynamic electricity, by M. E. Bichat.

Der Zoologische Garten.—In the January number, the first article is a description of the new Zoological Gardens at Frankfort, by the director, Dr. Max Schmidt, illustrated by a coloured plan. J. von Fischer gives an account of the habits of *Herpestes galera* as observed in confinement. E. Buck figures and describes an apparatus for producing currents in the water of aquaria; it may be worked either by a miniature steam-engine or by clockwork. H. Schacht gives minute details of the breeding habits of the common swallow (*Hirundo rustica*); and A. B. Meyer and K. von Rosenberg both write upon the newly discovered Bird of Paradise (*Diphyllodus Gulielmi III.*, Van Muschenbroek) from Ternate.—In the February number is printed a paper read by Dr. Hermann Müller before the Provincial Society of Westphalia, on the stingless Brazilian Honey-bees of the genus *Melipona*, and the possibility of their acclimatisation in Europe. Dr. J. J. Rein remarks on the distribution of some of the mammals of Japan; and C. Geitel writes on the feeding of small birds in winter in the neighbourhood of human habitations.

Poggendorff's Annalen der Physik und Chemie, 1875, No. 2, contain the following papers:—On the galvanic conducting capacity of melted salts, by F. Braun. The author experimented with twelve different salts, and tabulates his results; the salts were nitrates of potash, soda and silver, carbonates of potash and soda, sulphate of soda, chlorides of potassium, sodium, strontium, zinc and lead, and iodide of potassium.—On a compilation of facts which prove a decrease of volume as a consequence of chemical action in solid bodies, by W. Müller.—On the electric conducting capacity of the chlorides of the alkalies and alkaline earths as well as of nitric acid in aqueous solutions, by F. Kohlrausch and O. Grotrian. This is the last part of the author's interesting communications, and treats of the liquids examined, of the resistances observed, of the conducting capacities in their relation to that of mercury, and of their dependence on temperature; further, of their proportion to the percentage of concentration of liquids, of the co-efficients of temperature, and of the conducting capacity of dilute solutions.—On the theory of galvanometers, by H. Weber.—A reply to Baron Eötvös' remarks on a part of the astronomical undulation-theory by Ed. Ketteler.—Some remarks upon Helmholtz's work on Sound, "Die Lehre von den Tonempfindungen," by Emil v. Quanten; these remarks relate principally to what Helmholtz says on vowels.—A reply to Herr C. Heumann regarding his claim of priority in observing the action of nitrate of silver upon sulphide of copper, by R. Schneider.—On the construction of lightning conductors, by Dr. W. A. Nippoldt. Some remarks by Dr. G. Baumgartner, on Prof. E. Edlund's paper on the nature of electricity.—Description of a very simple apparatus to photograph spectra, by Hermann W. Vogel; this apparatus can even be applied to an ordinary pocket spectroscope of the smallest dimensions.—On the phenomena of interference visible on mirrors covered with dust or a fine layer of grease, by Prof. M. Sekulic.—Researches on apparent adhesion, by J. Stefan.—On the conducting capacity of the halogen compounds of lead, by E. Wiedemann.

Transactions of the Manchester Geological Society, Part viii. vol. xiii., 1874–75.—Nearly the whole of this part is occupied by an elaborate illustrated paper on "Hæmatite Deposits," by Mr. J. D. Kendall. There is a short paper by Mr. A. W. Waters on "Tertiary Coals," in reference to specimens of carbonised peat he found in Northern Italy under rather peculiar circumstances. Part ix. is occupied with the discussion on Mr. Kendall's paper on Hæmatite deposits, and with a long paper on basalt and its effects, by Mr. G. C. Greenwell, F.G.S.

SOCIETIES AND ACADEMIES

London

Royal Society, April 29.—"On a Continuous Self-Registering Thermometer," by H. Harrison Cripps. Communicated by Prof. Stokes, Sec. R.S.

The instrument is divided into two portions:—First, the thermometer, which marks the degrees; secondly, the clockwork, which indicates the hours and minutes. The thermometer is first described. The form in which it was originally made, and which perhaps serves best for illustrating the principle, was the following:—A glass bulb, rather more than an inch in diameter, ends in a glass tube 12 inches long, having a bore of $\frac{1}{8}$ inch. This tube is coiled round the bulb in such a manner as to form a complete circle four inches in diameter, the bulb being in the centre of this circle. Fixed to opposite poles of the bulb, exactly at right angles to the encircling tube, are two needle-pointed pivots. These pivots work in minute metal depressions fixed to the sides of two parallel uprights. It will be seen from this arrangement that the bulb with its glass tube will rotate freely between the uprights, and the pivots will be the centre of a circle, the circumference of which is formed by the glass tube. The bulb is filled with spirit in such quantity that at 60° Fahrenheit the spirit will fill not only the bulb, but about 4 inches of the tube. Mercury is then passed into the tube till it comes into contact with the spirit, and in such quantity as to fill up about three inches of the remaining portion of the tube. The spirit is now heated to 120°, and as it expands forces the column of mercury in front of it till the mercury comes within $\frac{1}{4}$ inch of the end of the tube. The tube is then hermetically sealed, enclosing a small quantity of air. If the thermometer be now arranged with its needle-points between the uprights, it will be observed that, as the spirit contracts on cooling, it draws the column of mercury with it. This immediately alters the centre of gravity, and the bulb and tube begin to revolve in a direction opposite to that of the receding mercury. On again applying heat, and the mercury passing forwards, the bulb regains its original position. By this simple arrangement, the two forces, heat and gravity, acting in contrary directions, generate a beautifully steady rotatory movement. The method by which this movement is made serviceable for moving the register will now be described. A grooved wheel, two inches in diameter, is fixed to one of the central pivots, therefore revolving with the bulb. Directly above, and at a distance of seven inches from this wheel, is fixed between needle-points another wheel of exactly similar size. Around and between these two wheels passes a minute endless chain. To the chain is fixed a tiny pencil, which will be carried backwards and forwards between the wheels in a perpendicular line. This constitutes the register worked by the thermometer. The clockwork portion of the machine is so arranged that it causes a vertical cylinder, four inches diameter and five inches in length, to revolve once in twenty-four hours. Round this cylinder is fixed a piece of paper twelve inches long, five inches wide.

On the paper in the direction of its greatest length are ruled 100 lines, $\frac{1}{20}$ inch apart, each indicating 1° Fahrenheit. Across the paper, at right angles to these lines, are ruled twenty-four lines in dark ink, indicating the hours; between these three others, more lightly marked, for the quarters. The cylinder is so placed that as it revolves the surface of the paper is $\frac{1}{10}$ of an inch away from the point of the pencil register moving at right angles to its surface. A small striker is connected with the clockwork in such a manner that every five minutes (or oftener if required) it gives the pencil a gentle tap, thus striking its point against the paper. By this means all friction of the moving pencil against the paper is avoided, and the index is marked by a series of dots.

"Some particulars of the Transit of Venus across the Sun, 1874, Dec. 9, observed on the Himalaya Mountains, Mussoorie, at Mary Villa."—Note II., with appendix, by J. B. N. Hennessey, F.R.A.S.

Linnean Society, May 6.—Dr. G. J. Allman, F.R.S., president, in the chair.—The following papers were read:—On the anatomy of two parasitic forms of *Tetrarhynchidæ*, by Mr. F. H. Welch.—Notes on the Lepidoptera of the family *Zygænidæ*, with descriptions of new genera and species, by Mr. A. G. Butler, F.L.S. The main object of the paper was to rescue this section of Lepidoptera from the confusion into which it had been brought by the creation of new species and genera on insufficient grounds, by Mr. J. Walker. Some very curious instances of mimetism were mentioned between parallel series of species of hornet-moths and of Hymenoptera.—On the characteristic colouring matters of the red groups of Algæ, by Mr. H. C. Sorby, F.R.S. In this paper the author gave an account of some of the leading characters of the various remarkable blue, purple, and red substances soluble in water characteristic of red Algæ. The compound nature of the solutions obtained from the plants may be proved by the varying decomposing action of heat on the different colouring matters. He also showed that though *Oscillatoriæ* and *Rhodosporeæ* yield closely-related colouring substances, the specific differences serve to separate these two groups of Algæ quite as much as their general structure. Connecting links do indeed occur, and the further study of this question will probably yield interesting results. Specimens illustrating these facts were exhibited. A discussion followed, in which the President, Prof. Dyer, Mr. A. W. Bennett, and others took part.

Chemical Society, May 6.—Dr. Odling, F.R.S., vice-president, in the chair.—Prof. N. S. Maskelyne read a paper on Andrewsite and Chalcosiderite, the former of which is a new mineral from Cornwall named after Prof. Andrews. There were also papers entitled "An examination of methods for effecting the quantitative separation of iron, sesquioxide, alumina, and phosphoric acid," by Dr. W. Flight; and "On sodium ethylthiosulphate," by Mr. W. Ramsay.—Mr. J. Williams, in his communication "On a milligrade thermometric scale," proposes to substitute the freezing and boiling points of mercury for those of water, and to divide the scale into a thousand parts.—Mr. C. Griffin exhibited and described some new gas furnaces which are very economical and of great power.

Zoological Society, May 4.—Mr. E. W. H. Holdsworth in the chair.—Mr. Sclater exhibited and made remarks on a skin of a chick of a Cassowary (*Casuarius picticollis*), received from Dr. George Bennett, of Sydney, New South Wales. The bird had been obtained alive from the natives in Milne Bay, New Guinea, by Mr. Godfrey Goodman, Staff Surgeon, R.N., when in the *Basilisk* in 1873.—Prof. Newton exhibited and made remarks on a series of tracings of some hitherto unpublished drawings discovered in the Library of Utrecht, representing the Dodo and other extinct birds of Mauritius. Prof. Newton also exhibited and made remarks on two specimens of Ross's Arctic Gull, *Rhodostethia rossi*, one of the rarest of Arctic birds.—Mr. H. C. Sorby, F.R.S., read a paper on the colouring matter of the shells of birds-eggs as studied by the spectrum method, in which he showed that all their different tints are due to a variable mixture of seven well-marked colouring matters. Hitherto the greater part of these had not been found elsewhere. The principal red colouring-matter was connected with the hæmoglobin of blood, and the two blue colouring matters were probably related to bile pigments; but in both cases it was only a chemical and physical relationship, and the individual substances were quite distinct, and it seemed as though they were special secretions. There appeared to be no simple connection between the production of these various egg-pigments and the general organisation of the birds, unless it were in the case of the Tinamous, in the shells of the eggs of many species of which occurs an orange-red substance not met with in any other eggs, unless it were in those of some species of Cassowary.—Mr. A. H. Garrod read a note on the hyoid bone of the Elephant, as observed in two specimens of the Indian Elephant which he had lately dissected, and showed that the position of the bone *in situ* had been mis-stated by former authorities.—A second paper by Mr. Garrod contained remarks on the relationship of two pigeons, *Ianthænas leucolæma* and *Erythrænas pulcherrima*, which he lately had an opportunity of examining.—A communication was read from Mr. G. E. Dobson on the bats belonging to the genus *Scotophilue*, in which he gave the description of a new genus and species allied thereto. The specimen in question had been obtained in the Bellary Hills, India, by the Hon. J. Dormer, by whom it had been presented to the British Museum. It was proposed to name it *Scotozous dormeri*.—A communication was read from Lieut. W. Vincent Legge, R.A., giving particulars of the breeding of certain Grallatores and Natatores on the south-eastern coast of Ceylon, together with notes on the nestling plumages of the same.

Geological Society, April 28.—Mr. John Evans, V.P.R.S., president, in the chair.—The following communications were read:—"On *Stagonolepis Robertsoni*, and on the evolution of the Crocodilia," by Prof. T. H. Huxley, Sec. R.S. After referring to his paper read before the Society in 1858, the author stated that he had since obtained, through the Rev. Dr. Gordon of Birnie, and Mr. Grant of Lossiemouth, further materials, which served at once to confirm the opinion then expressed by him, and to complete our knowledge of *Stagonolepis*. The remains hitherto procured consist of the dermal scutes, vertebræ of the cervical, thoracic, lumbar, sacral and caudal regions, ribs, part of the skull and the teeth, the scapula, coracoid and interclavicle, the humerus, and probably the radius, the ilium, ischium and pubis, the femur, and probably the tibia, and two metacarpal or metatarsal bones. The remains procured confirm the determinations given by the author in his former paper, except that the mandible with long curved teeth therein, superstitiously referred to *Stagonolepis*, proves not to belong to that animal. From the extant evidence it appears that in outward form *Stagonolepis* resembled one of the existing Caimans of intertropical America, except that it possessed a long narrow skull, like that of a Gavial. The dermal scutes formed a dorsal and ventral armour, but the dorsal shield did not contain more than two, nor the ventral shield more than eight longitudinal series of scutes. The posterior nares were situated far forward, as in lizards, neither the palatine nor the pterygoid bones uniting to prolong the nasal passage backwards, and give rise to secondary posterior nares, as in existing crocodiles. The teeth referred to *Stagonolepis* have short, swollen, obtusely pointed crowns, like the back teeth of some existing crocodiles; they sometimes present signs of wear. The scapula resembles that of recent crocodiles; the coracoid is short and rounded like that of the Ornithoscelida and of some lizards, such as *Hatteria*. The humerus is more Lacertian than in existing crocodiles. The acetabular end of the ischium resembles that of a lizard, and the rest of the bone is shorter dorso-ventrally and longer antero-posteriorly than in living crocodiles, thus resembling that of *Belodon*. The latter reptile, from the Upper Keuper of Würtemberg, is the nearest ally of *Stagonolepis*; both are members of the same natural group, and this must be referred to the order Crocodilia, which was described as differing from other Reptilia as follows:—The transverse processes of most cervical and thoracic vertebræ are divided into more or less distinct capitular and tubercular portions, and the proximal ends of the corresponding ribs are correspondingly divided; the dorsal ends of the subvertebral caudal bones are not united; the quadrate bone is fixed to the side of the skull; the pterygoids send forward median processes which separate the palatines and reach the vomer; there is an interclavicle, but no clavicles; the ventral edge of the acetabular portion of the ilium is entire or but slightly excavated; the ischia are not much prolonged backwards, and the pubes are directed forwards and inwards; the femur has no inner trochanter, and the astragalus is not a depressed concavo-convex bone with an ascending process. There are at least two longitudinal rows of dorsal dermal scutes. The Crocodilia are divided by the author into three sub-orders:—

1. Parasuchia, with no bony plates of the pterygoid or palatine bones to prolong the nasal passages; the Eustachian pas-

sages enclosed by bone; the centra of the vertebræ amphicœlian; the coracoid short and rounded; the ala of the ilium high, and its acetabular margin entire; and the ischium short dorso-ventrally and elongated longitudinally, with its acetabular portion resembling that of a lizard. Genera: *Stagonolepis, Belodon.*

2. Mesosuchia, with bony plates of the palatine bones prolonging the nasal passages, and giving rise to secondary posterior nares; a middle Eustachian canal included between the basioccipital and basisphenoid, and the lateral canals represented only by grooves; vertebral centra amphicœlian; coracoid elongated; ala of the ilium lower than in the preceding, higher than in the next sub-order, its acetabular margin nearly straight; ischium more elongated dorso-ventrally than in the preceding group, with its acetabular margin deeply notched. Genera: *Steneosaurus, Pelagosaurus, Teleosaurus, Teleidosaurus, Metriorhyncus* (*Goniopholis* ?, *Pholidosaurus* ?).

3. Eusuchia, with both pterygoid and palatine bones giving off plates which prolong the nasal passages; vertebral centra mostly procœlous; coracoid elongated; ala of the ilium very low in front, its acetabular margin deeply notched; ischium elongated dorso-ventrally, with its articular margin deeply excavated. Genera: *Thoracosaurus, Holops*, and recent forms.

The Mesosuchia are intermediate in character between the other two groups; the Parasuchia, where they differ from the Mesosuchia, approach the Ornithoscelida and Lacertilia, especially such as *Hatteria* and *Hyperodapedon*, with amphicœlous vertebral centra. The Eusuchia, on the other hand, are the Crocodilia which depart most widely from the Ornithoscelida and Lacertilia, and are the most Crocodilian of crocodiles. After indicating at some length the succession of modifications in the above three groups, the author remarked that if there is any solid ground for the doctrine of evolution, the Eusuchia ought to be developed from the Mesosuchia, and these from the Parasuchia, and showed that geological evidence proved that the three groups made their appearance in order of time, in accordance with this view. Thus, in the Trias there are the genera *Belodon* and *Stagonolepis* of the sub-order Parasuchia. In the Upper Lias we have *Steneosaurus* (*Mystriosaurus*) and *Pelagosaurus*, the first represented also in all Mesozoic formations up to the Kimmeridge Clay; in the Fuller's Earth *Teleosaurus* and *Teleidosaurus* occur; in the Kelloway Rock *Metriorhynchus*, also met with in the Oxford Clay and Kimmeridge Clay; in the Wealden, *Goniopholis, Macrorhynchus, Pholidosaurus*, and unnamed Teleosaurians; and in the Upper Chalk, *Hyposaurus;* all belonging to the Mesosuchia. In the Upper Chalk, again, the Eusuchia make their appearance, represented by the genera *Thoracosaurus, Holops*, and *Gavialis* (?). How far back the Parasuchia extend in time is not known, but they are not found in any formation subsequent to the Upper Trias. The author described a fragment of a skull of a Wealden crocodile, in which the posterior nares are smaller and situated further back than in *Metriorhynchus* or *Steneosaurus.* Of the nearest allies of the Crocodilia, the Lacertilia and Ornithoscelida, the former may be traced back from the present day to the Permian epoch, and the latter from the later Cretaceous to the Triassic epoch. The author discussed the question whether these types exhibit any evidence of a similar form of evolution to that of the Crocodilia. The cranial structure of the Permian Lacertilia is almost unknown, and the only important deviation from the type of the existing Lacertilia in the skeleton is that their vertebræ are amphicœlous, not procœlous. With this exception there is no evidence that the Lacertilian type of structure has undergone any important change from later Palæozoic times to the present day; and this change seems to have occurred earlier in the Lacertilia than in the crocodiles, as a sacral vertebra of a lizard from the Purbecks has the centrum concave in front and convex behind. With regard to the Ornithoscelida, the author noticed that the researches of American palæontologists proved the existence of those reptiles in abundance in quite the latter part of the Cretaceous epoch. He had himself indicated the existence of varied forms of Dinosauria in the Trias. He confirmed his former opinion that *Zanclodon* from the Upper Keuper of Würtemberg is a Dinosaur, and probably identical with *Teratosaurus* (von Meyer), in which case its affinity to *Megalosaurus* is exceedingly close. He corrected a statement in a former paper with regard to the ilium of the Thecodontosaurians, which he had turned the wrong way, and stated that when regarded in its proper position this ilium is much more Lacertilian than that of *Megalosaurus.* From this and other evidence of detail he inferred that the Triassic Thecodontosauria were devoid of some of the most marked peculiarities of the later Ornithoscelida, while the most ornithic of the latter belong to the second half of the Mesozoic period. The oldest crocodiles differ less than the recent ones from the Lacertilia, and the oldest Ornithoscelida also approach a less differentiated Lacertilian form, the two groups seeming to converge towards the common form of a lizard with Crocodilian vertebræ. *Cetiosaurus* is also a reptile with a vertebral system like that of the Thecodontosauria and Crocodilia, but with more Lacertilian limbs, and *Stenopelyx* may be in the same case. It may therefore be convenient hereafter to separate the Thecodontosauria, *Cetiosaurus* and perhaps *Stenopelyx* as a group, "Suchospondylia," distinct from both the Ornithoscelida and the Crocodilia (or "Sauroscelida").

"On the remains of a fossil forest in the Coal-measures at Wadsley, near Sheffield," by H. C. Sorby, F.R.S., Pres. R.M.S. In this paper the author described the occurrence of a number of stumps of *Sigillariæ* in position and with Stigmarian roots attached to them in the Coal-measure Sandstone in the grounds of the South Yorkshire Lunatic Asylum.—"On *Favistella stellata* and *Favistella calicina*, with notes on the affinities of *Favistella* and allied genera," by Mr. H. Alleyne Nicholson, F.R.S.E.

Mr. A. Tylor brought an apparatus for determining the heat evolved by the friction of ice upon ice, with a view to explain an important element in glacier motion. The apparatus, consisting of plates of ice eight inches square, placed in a wooden chuck three inches deep, was enclosed in a double sheet-iron case containing ice and salt, and kept at 32° F. One block of ice was rotated, and the other pressed against it. Four pounds of ice were reduced to water at the rate of 1¼ lb. in an hour, in consequence of the motion, that is by the heat evolved by friction of ice upon ice, the pressure being 2 lbs. on the square inch. Ice evaporates at 32°, and the same quantity of ice was reduced, when still, at about the rate of ¼ lb. in an hour at 32° F. Air at a higher temperature found its way into the case, and promoted melting. When this experiment was tried in a room at 54° F. with the same apparatus without any outer case, the friction of the ice in motion, at the above pressure, increased the production of water 3½ times above the rate observed when the ice was still and exposed to a temperature of 54° F. The amount of heat evolved was nearly as much as in oak moving upon oak well lubricated, and the coefficient of friction was between 0·1 and 0·2. Glacier motion is impossible without a continual supply of water to lubricate the bottom. No doubt the action of denudation by glaciers produces heat to a small extent. The water obtained by melting the surface of the glacier by the sun's heat in the glacial period could not be sufficient alone. The position of deep lakes in all parts of the world in immediate connection with mountains, and never in places away from mountains, shows that lakes are integral parts of mountains; and, in fact, lakes are deepest exactly where the glaciers, once covering the mountains, were in a position to act as lake excavators. There can be no doubt that all deep lakes in the world, including those in Central Africa, below the Equator, are purely of glacial origin, and that the cold in the glacial period was nearly equally intense in the southern and northern hemispheres. The surface-ice would move much faster than the bottom ice, and the side-ice than the surface-ice, and therefore fractures would be continually occurring through all parts. The water produced by this great friction of ice upon ice would fall through the fissures to the bottom. He had pointed out that a glacier moved twice as fast when it was eight times as thick, and the influence of weight on motion must be considered a most important element. The present temperature of a thin glacier was found by Agassiz, from observation, to be one-third of a degree below freezing; but Mr. Tylor assumed that in such a lake-glacier as he had drawn, and supposed to exist in the glacial period, the temperature might be assumed to be very much below freezing, the greater cold arising from immense evaporation and other causes. He therefore concluded that the water produced by friction of ice upon ice falling to the bottom of the lake glacier through fissures would rapidly freeze, and thus expanding one tenth, would impel the glacier (shod or armed with blocks of stone and sand at the bottom) up a gradient of 1 in 20, excavating the Swiss and other lakes thirty or forty miles long, and 1,200 feet deep, in this manner. Mr. Tylor calculated that with half the work per annum of mean lake-excavation the lake of Zurich could be excavated in 15,000 years. Prof. Ramsay had pointed out, from geological evidence, that such lakes have been excavated by ice, but he did not indicate how this was mechanically possible (see *Quarterly Journal*, 1862). Mr. Tylor referred again to his experiment when the pressure was only 2 lbs. on the inch. In a large glacier such as that described by Dr. Hooker in the Himalayan range, where the mean gradient of the surface was 40° to 50° and the actual fall was 14,000 feet in five or six miles, Dr. Hooker found great lakes attendant upon the mountains. Supposing the ice was a mile thick, the pressure would be half a ton on the inch, in the Himalayas at least, and the production of water by friction of ice upon ice enormous. Friction is dependent upon pressure and distance moved, and independent of velocity of motion.

Anthropological Institute, April 27.—Col. A. Lane-Fox, president, in the chair.—Mr. Francis Galton, F.R.S., contributed a note on the height and weight of boys aged fourteen, in town and country schools. The principal results showed the comparative heights and weights of those boys who were fourteen on their last birthday, in two groups of public schools, the one group of country schools and the other of town schools. It appeared that boys of fourteen in the country group were about 1¼ inches taller and 7 lbs. heavier than those in the town group, and that the difference of height was due in about equal degrees to retardation and to total suppression of growth; and that the distribution of heights in both cases conformed well to the results of the "Law of Error."—Rev. Joseph Mullens, D.D., read a paper on the origin and progress of the people of Madagascar. The Malagasy appeared to be a single race. No tribe is to be found secluded in any corner or in the hill districts different from the people of the plains or open provinces such as is met with in India, in Sumatra, and in Borneo; nor is any portion of the people specially degraded. The Malagasy are divided into three tribes—the Betsimisarakas, the Sacalavas, and the Hovas, the latter largely predominating in numbers and influence. With regard to the origin of the people, the author rejected the theory of Crawfurd and others, who argued for their African descent. Their language and tribal customs suggested a very different origin. There could hardly be any doubt that the Malay entered largely into the composition of the grammar and vocabulary, and continued researches into the Malay and Malagasy languages gave more and more evidence of their resemblances. The conclusion was that the Malagasy are a Malay people, following Malay customs, some of them possessing Malay eyes, hair, and features, and speaking a Malay tongue at the present time. They were an intelligent people, orderly, were well governed, and were daily improving, and the author of the paper could see the promise of a great and useful future for them.—Mr. J. J. Monteiro read a paper on the Quissama tribe of Angola, which he had written with the object of correcting some erroneous statements concerning them that had been formerly brought before the Institute.

CAMBRIDGE

Philosophical Society, March 8.—The following communications were made by Mr. W. T. Kingsley:—(1) On the cause of the "wolf" in the violoncello; (2) A description of the instruments used in sounding some of the lakes in the Snowdon district, and an account of the results obtained. Mr. Kingsley said that the "wolf" occurs somewhere about the low E or E flat, and was attributed to the finger-board having the same pitch, so that the finger-board becomes as it were a portion of the string stopped down on it and vibrates with it: if this is the true cause, the "wolf" cannot be got rid of, but may be placed at such a pitch between E and E flat as to occur on a note rarely used; also by thickening the neck of the finger-board, the extent of discursion in the vibration may be made less.—The Master of St. Catharine's College remarked that a different explanation of the phenomenon was given by M. Savart, which was to this effect. The old Italian makers constructed the violoncello of such dimensions that the mass of air included within the instrument resonates to a note making 85·33 vibrations in a second, a number which then represented the lowest F on the C string, but which now, owing to the rise of pitch since the beginning of the eighteenth century, nearly represents the note E immediately below it. Savart's theory was that notes half a tone above or below this E will cause beats between the vibrations of the string and those of the mass of included air. It seemed quite possible that the mass of air contained in the instrument should be capable of controlling the vibrations of the whole instrument, but not that the vibrations of the finger-board alone (as Mr. Kingsley suggested) could do this. For the sound, technically called the "wolf," is an actual check to the whole vibration of the violoncello, producing not merely beats, but a baying sound, destitute of the freedom of vibration which characterises other notes. But a great objection to the above explanation is this experiment. On an Italian instrument, the upper D on the fourth or lowest string is the imperfect note. But when the same note is elicited from the third string, the note is perfectly resonant. This peculiar effect seems then to depend upon the point of the finger-board which is pressed. It is also well known that the "wolf" can be modified by an alteration of the position of the sound-post. As an explanation, we may conceive that the whole framework of the violoncello vibrates like a stretched string, producing its fundamental, with a series of overtones, and that a nodal line passes through the point of the finger-board, pressure upon which produces the "wolf," and that thus, all vibrations being destroyed except those which have a node at the point of pressure, this peculiar tone is elicited.—Mr. Kingsley then gave a description of the plummet, registering apparatus, and protractors used by him in sounding several of the deep lakes in the Snowdon district last June. The plummet is a modification of the deep-sea plummet now generally used, the principal alteration being in the application of a heavy gouge to aid in bringing up specimens of the bottom. The recording apparatus is a modification of the paying-out apparatus used for laying deep-sea telegraph cables. The protractors are diagonal telescopes mounted on bars revolving on vertical axes, and having fiducial edges radiating from the centres of the axes. One protractor is placed at each extremity of the base on a horizontal table, on which is strained a sheet of drawing paper; the telescopes are first collimated with each other, and then a line is drawn by the fiducial edges on each sheet of paper; the boat with the sounding apparatus is followed by the two observers at the protractors, and when a signal is given, a line is ruled and numbered by each observer; finally, the two papers are placed so as to have the lines of collimation in coincidence and the centres at the scale distances apart; then by looking through the papers and pricking the intersections of the corresponding lines, the positions of the boat are laid down on two maps. In practice this is all done easily, and no particular skill is needed in the observers with the protractors. The results obtained showed that the bottoms of these lakes are comparatively flat, the greatest depths being reached at a short distance from the shore on the cross section, and occurring also nearer to the upper end of the lake than to the lower: the forms of the bottoms correspond in a remarkable manner with the set that would be given to glaciers descending into the hollows in which the lakes lie; and Mr. Kingsley believed them to have been formed by the action of glaciers during the extreme cold or penultimate glacier epoch; because in one case, that of Llyn Cawlyd, the lake lies almost on a watershed, where no glacier could now form, but which was a depression forming a lateral outflow from the great glacier that at one time filled the whole hollow between the Glydyns and Carnedds; during the last glacier epoch most of these hollows were again filled with ice to a great height, but these last glaciers were comparatively small. Mr. Kingsley especially dwelt upon the difficulty of disentangling the scattered moraine from the drift, and also of distinguishing between the striations belonging to the two cold epochs.

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THURSDAY, MAY 20, 1875

THE UNSEEN UNIVERSE

The Unseen Universe; or, Physical Speculations on a Future State. (London: Macmillan and Co., 1875.)

THIS book, which rumour attributes to a co-partnery of two distinguished physicists, will at least serve to prove one thing, that scientific men are not necessarily unbelievers, and that some scientific men accept frankly and fully the whole of what is generally understood as the scheme of Trinitarian Christianity, and find in it the most adequate expression of their own physical speculations. Whether their readers agree with or differ from the authors, they cannot fail to recognise the extent of their information and the freedom of their reasoning. There is no attempt to make anything square with preconceived theories, and although we doubt whether the writers would have arrived at their conclusions without the accepted scheme of orthodox Christianity to serve them as a clue, it is equally clear that they rest them on what they think adequate scientific evidence.

The preliminary chapter states the fact of the all but universal belief in, or aspiration after, Immortality. It admits that that doctrine is inconsistent with the doctrine of continuity as generally understood and as applied solely to the visible universe. It accepts and explains the principle of continuity in the fullest sense, and it attempts to reconcile it, as thus apprehended, with the doctrine of immortality. Incidentally—out of the apparent waste of energy in space, and on other indications chiefly teleological—it constructs a hypothesis of an invisible universe, perhaps developed out of another invisible universe, and so on *ad infinitum*. It is another consequence of the theory that our natural bodies are probably accompanied by a sort of invisible framework or spiritual body, and that the phosphorus and other substances of which the natural body is built up are not really identical with these elements in their ordinary condition of inorganic atoms, but are somehow transubstantiated by the co-existence, along with the mere chemical substance or with its chemical properties, of this invisible, imponderable, immaterial, accompanying essence, which derives a kind of *vis vivida* from a connection with the unseen universe. The passage from the visible universe to the invisible seems to be made intelligible to the authors by the existence of the ether, a substance into which energy is continually being passed, and into which it is perpetually, and, so far as any obvious or sensible effect is concerned, finally, absorbed.

As a first postulate the authors assume the existence of a Creator. Finite beings, creatures, are conditioned by the laws of the universe, and it is in these conditions that we must seek to discover its nature. The first pair of subjects for human thought are matter and mind, and the materialists tell us, that whereas mind or mental activity never exists without being associated with some forms of matter, we may perfectly conceive matter, as for instance a block of wood or a bar of iron, existing without intelligence. Is mind then the dependant—is there nothing in matter which serves as the vehicle of intelligence different from all other matter? The authors answer that we have no right to assume that the brain consists of particles of phosphorus or carbon such as we know these substances chemically, that we cannot say that there may not be something superadded to their chemical and physical qualities. They dwell upon another fact—the fact that individual consciousness returns after sleep or trance; a fact inferring some continuous existence. The assumptions of the materialist are less inevitable than he supposes. Turning to mind, finite conditioned intelligence, the authors ask, what is essential to it? It must have some organ by which it can have a hold upon the past, and such a frame and such a universe as supply the means of activity in the present. Outside they find physical laws, and they look on the principle of continuity as something like a physical axiom. By this principle we are compelled to believe that the Supreme Governor of the Universe will not put us to permanent intellectual confusion. It is in the nature of man, certainly in the nature of scientific man, to carry the explanation of everything back *ad infinitum*, and to refuse perpetually to grant what is perpetually demanded of him, that he has arrived at the inexplicable and unconditioned. On this principle scientific men have supposed themselves to prove that the physical universe must one day become mere dead matter. The authors consider that this is a monstrous supposition, although they grant that the *visible*, or by-sense-perceivable universe, *must in transformable energy, and probably in matter*, come to an end. They think that the principle of continuity itself demands a continuance of the universe, and they are driven to believe in something beyond that which is visible as the only means of explaining how this system of things can endure in the future, or can have endured for ever in the past. They see a visible universe, finite in extent and finite in duration, beyond which, o both sides stretching infinitely forward and infinitely backward, there is an invisible, its forerunner and its continuation. It is natural to infer that these two invisibles must meet across the existing finite visible universe. As we are driven to admit the invisible in the past and in the future, there must be an invisible framework of things accompanying us in the present.

What then is this present visible universe; and can we point to sure signs of this invisible substance which accompanies what may prove after all to be the mere shadow of things? Matter has two qualities. The first is that it is indestructible; the second, that the senses of all men alike point to the same quantity, quality, and collocation of it. Our practical working certainty of the existence of matter means (1) that it offers resistance to our imagination and our will; and (2) that it offers absolute resistance to all attempts to change its quantity. Certain other things—notably energy—are in the same sense conserved, and if we recognise the transmutability of energy of motion into energy of position, we may say that energy is equally indestructible with matter itself. But energy is undergoing a perpetual self-degradation. All other forms of energy are slowly passing into invisible heat motions, and when the heat of the universe has ultimately been equalised, as it must be, all possibility of physical action or of work will have departed. Mechanical effort cannot longer be obtained from it. The perfect heat-engine only converts a portion of the heat into work; the rest is lost for ever as an available source of work. There is indeed a sort of wild and far-off possibility by which a little more work *might* be got out of a uniform temperature universe, if we could suppose Clerk-Maxwell's demons—"mere guidance applied by human intelligence"—occupied in separating those particles of a heated gas which are moving faster than the average from those which are moving slower. But this is but a broken reed to trust, and it would at the best avail us little. What must happen in the existing physical system would be this: the earth, the planets, the sun, the stars, are gradually cooling; but infinitely numerous catastrophes by which the enormous existing store of energy of position may be drawn upon, may over and over again restore unequal temperature. The fall together, from the distance of Sirius, of the sun and another equal sun would supply the former with at least thirty times as much energy as can have been obtained by the condensation of his materials out of a practically infinite nebulous mass of stones or dust. But these catastrophes can only delay the inevitable. If the existing physical universe be finite—and the authors never seem to realise the speculative possibility that it may not be so—the end must come, unless there be an invisible universe to supplement and continue it.

What is the ultimate nature of matter, and especially of the ether, which is the vehicle of all the energy we receive from the sun? There have been four theories, for each of which something may be said. There is the Lucretian theory of an original, indivisible, infinitely hard atom, "strong in solid singleness;" Boscovich's theory that the atom or unit is a mere centre of force; the theory that matter, instead of being atomic, is infinitely divisible, practically continuous, intensely heterogeneous; and, finally, the theory of the vortex atom, a thing not infinitely hard and therefore indivisible, but infinitely mobile, so that it escapes all force which makes effort to divide it. What we call matter may thus consist of the rotating portions of a perfect fluid, which continuously fills space. Should this fluid exist, there must be a creative act for the destruction or production of the smallest portion of matter. Whichever of these theories we adopt, we must explain the simplest affection of matter—that by which it attracts other matter. There seems little possibility of doing so. The most plausible explanation is in Le Sage's assumption of *ultramundane corpuscles*, infinite in number, excessively small in size, flying about with enormous velocities in all directions. These particles must move with perfect freedom among the particles of ordinary matter, and if they do so we can understand how, through the existence of the ultramundane particles, two mundane particles attract inversely as the square of the distance. On this theory the energy of position is only the energy of motion of ultramundane and invisible particles—and a bridge is built between the seen and the unseen. These ultramundane particles are something far more completely removed from all possibility of sensible qualities than the ether which Sir William Thomson has attempted to weigh. Struve has speculated upon the possibility that it is not infinitely transparent to light, and his calculations, based on the numbers of stars of each visible magnitude, lead him to suppose that some portion of the light and energy from distant suns and planets may be absorbed in it. The ether is thus a kind of adumbration or foretaste of the invisible world. It may have certain of the properties of that world which is perceived by sense, but it is probably subject only to a few of the physical conditions of ordinary matter.

Let us look once more at the substance of the universe. We recognise that it is impossible to suppose any existing state but as the development of something pre-existing. To suppose creation, is to suppose the unconditioned. Creation belongs to eternity, and not to time. This being so, it is difficult to believe in the vortex ring theory, which regards the invisible universe as an absolutely perfect fluid. With an imperfect fluid, the eternity of visible matter which the vortex theory requires, disappears. Such a visible universe would be as essentially ephemeral as a smoke-ring—so that we may accept it as possible, if not probable, that the visible universe may pass away—that it may bury its dead out of its sight. In its present state we have three forms of development—Chemical, or Stuff Development, Globe Development, and Life Development. It is a question whether the ultimate atoms of chemists are really ultimate; whether some agent, like great heat, for instance, could not split them up into various groups of some primal substance like hydrogen. We see the prospect of a similar simplicity in the development of worlds on the theory of Kant and Laplace, which makes the systems of the universe the result of the gradual condensation of nebulous masses. In the end, all the masses of the universe must fall together—in the beginning there can have been no masses, everything being nebulous and discrete, even if ordinary matter be indestructible. The last state and the first state of the visible universe are thus separated from each other by a finite duration. A like simplicity may be reached in the development of life. Darwin has made it at least possible that all life may issue from some primordial life-germ. The complete refutation of the doctrine of abiogenesis—the practical proof that life issues only from life—leaves us still bound to account for that germ. There is no doubt that species develop varieties which may ultimately become distinct species, although there is little indication that the varieties of what was once one species are ever separated like species originally different, by a barrier of mutual infertility. A sufficient length of time might enable us to overcome this barrier. In all our developments—the substance development, the globe development, the life development—we are thus brought, in the end, to a something which we are not yet able to comprehend.

Turning from matter to the phenomena which affect it, we notice one singular set of phenomena in which things insignificant and obscure give rise to great lines of events. A whole mass of water, the temperature of which has been reduced below the freezing-point, suddenly crystallises on the slightest starting motion; a whole series of tremendous meteorological phenomena, such as hurricanes in the Indian Ocean, happen because certain positions of Mercury and Venus affect the sun's atmosphere, causing spots in his, and the condition of the sun affects the earth. Like the complicated series of effects which follow the pulling of the trigger of a gun, the effects are utterly disproportionate to their causes. Man is a machine of this unstable kind—some trivial change affecting the matter of the brain is all that is needed to set him in motion. May not other beings be capable of touching what we may call the hair-triggers of the universe? Whatever these agencies are, angels or ministering spirits, they certainly do not belong to the present visible universe. The writers examine the sacred records to confirm their speculations.

Thus, then, we have a visible and an invisible universe, and we have processes of delicacy in the former which at least suggest the action on it of agencies belonging to the latter. Let us look at the first phenomenon of the visible universe—the expenditure of energy in it. The sun's energy is issuing in what is apparently waste space just as it is issuing in that portion of space which is filled by our earth. What becomes of the energy—probably far more than half of that which proceeds from it—which proceeds apparently nowhere, speeding on with the velocity of light? Is it absorbed in the ether, and if so, what does the ether do with it? The writers suggest that the ether may preserve for intelligent beings the record of the past. But that seems scarcely sufficient use of the energies spent on it; the more so as the intelligent beings existing in the visible universe will certainly come to an end with it.

"We were led," say the authors, in a passage in which their whole theory is perhaps summed up, "to conclude that the visible system is not the whole universe, but only, it may be, a very small part of it; and that there must be an invisible order of things, which will remain and possess energy when the present system has passed away. Furthermore, we have seen that an argument derived from the beginning rather than the end of things assures us that the invisible universe existed before the visible one. From this we conclude that the invisible universe exists now, and this conclusion will be strengthened when we come to discuss the nature of the invisible universe, and to see that it cannot possibly have been changed into the present, but must exist independently now. It is, moreover, very closely connected with the present system, inasmuch as this may be looked upon as having come into being through its means.

"Thus we are led to believe that there exists now an invisible order of things intimately connected with the present, and capable of acting energetically upon it—for, in truth, the energy of the present system is to be looked upon as originally derived from the invisible universe.

"Now, is it not natural to imagine that a universe of this nature, which we have reason to think exists, and is connected by bonds of energy with the visible universe, is also capable of receiving energy from it? Whether is it more likely that by far the larger portion of the high-class energy of the present universe is travelling outwards into space with an immense velocity, or that it is gradually transferred into an invisible order of things? May we not regard ether or the medium as not merely a bridge between one portion of the visible universe and another, but also as a bridge between one order of things and another, forming as it were a species of cement, in virtue of which the various orders of the universe are welded together and made into one? In fine, what we generally call ether may be not a mere medium, but a medium *plus* the invisible order of things, so that when the motions of the visible universe are transferred into ether, part of them are conveyed as by a bridge into the invisible universe, and are there made use of or stored up. Nay, is it even necessary to retain the conception of a bridge? May we not at once say that when energy is carried from matter into ether it is carried from the visible into the invisible; and that when it is carried from ether to matter it is carried from the invisible into the visible

"If we now turn to thought, we find that, inasmuch as it affects the substance of the present visible universe, it produces a material organ of memory. But the motions which accompany thought will also affect the invisible order of things, and thus it follows, that '*Thought conceived to affect the matter of another universe simultaneously with this may explain a future state*' (see Anagram, NATURE, Oct. 15, 1874)."

Our notice has already extended so far that we shall not follow the authors into their examination of the Scriptures, and of certain Christian hymns in which the sentiments and feelings of the Christian world seem to them to be embalmed. We notice only two of the objections to their system, which they themselves state, and seem to us to fail to refute. It is said that "if energy is transferred from the visible into the invisible universe, its constancy in the present universe can no longer be maintained." The answer is, that this visible universe is not the whole universe, and that the conservation of energy principle is applicable only to the whole universe, visible and invisible together, except under special limitations. The retort is obvious, that in this sense, and except when these special limitations specially and finally remove the difficulty, the principle becomes unintelligible and useless. It is a mere theological dogma to say that what energy perishes in the visible passes into the invisible universe; and the dogma is worthless as a physical principle on which to build any physical reasoning. The other objection is, that the dissipation of energy must go on even in this invisible universe, and the new assumption only delays the inevitable end of all things. The answer made is, that the universe may be regarded as an infinite whole. We have no objection, but the same may be said of the visible universe, and the moment that it is so regarded the arguments on which its end and its beginning are inferred seem to vanish into air. An infinite universe will have an infinite store of energy, and there is no need to suppose that its store is ever exhausted, or that in any finite time it has become practically degraded and unavailable. The whole elaborate machinery of the invisible universe (p. 171), piled one on the top of the other, seems to us to fall like a house of cards, if we can accept the eternal duration of an infinite by-sense-perceptible universe.

The book is written in a simple and persuasive style, with a transparent simplicity and purity of purpose. Once or twice there is an outburst of irrepressible energy, like that on pp. 106 and 107, about wife-beaters, who are to be subjected "by an enlightened Legislature to absolutely indescribable torture, unaccompanied by wound or even bruise, thrilling through every fibre of the frame of such miscreants." But these outbursts are transient, and they relieve the strain on the reader's attention.

THE TIDES OF THE MEDITERRANEAN

Az Arapály Fiumei Obölben (*The Tides in the Roadstead of Fiume*). Prize Essay, published by the Royal Philosophical Society of Hungary. By E. Stahlberger, Professor in the Imperial Royal Marine Academy. (Buda-Pesth, 1874, 4to., pp. 109, with plates and copious tables.)

FEW points in physical geography have had more interest for scientific men than the tides of the Mediterranean. Connected with the Atlantic only by a strait of a few miles in width, this inland sheet of water is so effectually shut off from the general tidal movements of the main ocean, that it has often been called a "tideless sea." But this is not correct; for, having an extent of surface of some 700,000 or 800,000 square miles, it is sufficiently large to be itself specially affected by the attraction of the sun and moon, and thus it possesses a true, although small, tide of its own.

The daily variations in the level of the water have of course been always patent to the dwellers on the Mediterranean coasts; and, no doubt, careful observers must have remarked a periodicity in the recurrence of such variations, identifying them to a certain extent with the ocean tides. But from the small amount of the true periodical rise and fall, and from the large influence of accidental causes, the phenomena have been so irregular as to present great difficulties in their analysis; and, so far as we know, there has not been, down to the appearance of the present work, any systematic investigation of the subject put on record.

The present publication has arisen from a prize of 200*l.* having been offered in 1872 by the Royal Hungarian Society (from funds furnished by Government) for scientific labours bearing on the physical or meteorological conditions of the kingdom of Hungary.

Fiume is a town of some importance, lying on what is called the Hungarian *littorale*, washed by the waters of the Gulf of Quarnero, an irrregular-shaped recess in the extreme north-eastern part of the Adriatic. The Government of Hungary, desirous to promote the maritime interests attached to their little seaport, have established there a Marine Academy, and M. Stahlberger, one of the professors in that institution, had had occasion to make and register observations on the rise and fall of the water in the neighbouring roadstead. Conceiving that by studious labour the phenomena he had recorded might be reduced to something like rule and order, he undertook the elaborate theoretical discussion of them, and the Society, appreciating the value of the work, has not only awarded him the prize for it, but has published it, in full detail, for the benefit of science in general.

The author was led to this investigation by the double object of obtaining accurate information, first, as to the general phenomena of the tides in the Adriatic, or rather in the Mediterranean generally; and secondly, as to the peculiarities in these phenomena induced by local influences in the neighbourhood of the port of Fiume.

He remarks, in regard to the first point, that the semi-mensual irregularity which it is customary to deduce from observations, in order to predict the times of high and low water, is altogether different in the Adriatic from what obtains in regard to the ocean generally; and yet the causes of this difference have never yet been explained.

In regard to the second point, he refers to notices that had appeared of remarkable irregularities in the Fiume tides, which rendered further investigation very desirable. It had been perceived, that instead of the usual six hours' alternating ebb and flow, there was frequently only one high and one low water in the day; and, moreover, that the time of the lowest water advanced on the average two hours every month, or twenty-four hours in a year.

These strange phenomena had attracted attention, and in 1868 the Adria Commission of the Imperial Academy of Sciences at Vienna established a self-registering tide-gauge at Fiume, the control of which was entrusted to M. Stahlberger. The present essay contains the results of three years' observations, which are fully and scientifically discussed by him.

The tide-gauge was on a plan that has often been used in this country. It consisted of a float, which by means of connecting machinery and a pencil made a mark on a sheet of paper stretched on a drum. The drum being moved uniformly by clockwork so as to make one revolution in twenty-four hours, the height of the tide at any time of the day could be deduced by simple measurement from the curve produced on the paper. The same paper was used for three days' observations, the curves being distinguished from each other by different coloured pencils being attached at the beginning of each day.

The author appears to have gone to work in his investigation in a thoroughly philosophical way. He has first collected a very large number of facts, as shown by the records of his gauge; he has then tabulated them with great care and ingenuity, classifying them with special reference to the nature of the influences known to be in operation, such as the positions of the heavenly bodies, the direction and force of the wind, the state of the barometer, and so on; and finally, working on the records thus arranged, he has, by applying scientific calculations of a high order, been able to a large extent to simplify the complicated questions involved, and to throw much light on their explanation.

To facilitate the investigation, he divides the tidal phenomena into two classes: namely, in the first place, periodical motions of the water produced by cosmical causes; and secondly, non-periodical motions produced by the influence of meteorological or local agencies. He then discusses each of these two divisions at considerable length.

As to the periodical motions, he found that in calm weather, and even to a less extent at unsettled times, the figures drawn by the gauge showed unmistakable signs of periodicity; but the appearances were of two kinds: sometimes they showed two well-defined maxima and minima, six hours apart; at other times there was only a single maximum and minimum, sharply defined, these two types melting into each other with all gradations.

These regular forms were clearly to be referred to the periodical motions of the heavenly bodies, and the author, having carefully collected and arranged the facts, enters into a long and full theoretical discussion of their causes, according to the principles laid down by Newton and Laplace.

We cannot pretend to give any details of the laborious mathematical calculations which follow: it must suffice to extract the author's brief summary of his results on this head. He says that the periodical movements of the sea in the Gulf of Fiume depend in the first place on four simple oscillations, two of the sun and two of the moon; and secondly, on four other simple vibrations, two due to each body, which are reckoned in sidereal time, but which have only a slight effect, and may be neglected in computation.

If δ_m and δ_s represent the declinations of the moon and sun respectively, ρ_m and ρ their distances (expressed in terms of their respective mean distances), t_m and t_s the numb of lunar or solar hours (Mondbeziehungsweise Sonnenstunden) which have elapsed since the last upper culmination of either body respectively; then the theoretical elevation or depression of the sea in the Gulf of Fiume due to these causes for any given time is found in millimetres by the expression:—

$$112{\cdot}1\ \frac{\cos^2\delta_m}{\rho_m^{\,3}}\cos\frac{\pi}{6}\,(t_m - 8{\cdot}49)$$
$$+\ 272{\cdot}4\ \frac{\sin 2\delta_m}{\rho_m^{\,3}}\ \cos\frac{\pi}{12}(t_m - 4{\cdot}60) + 60{\cdot}3\ \frac{\cos^2\delta_s}{\rho_s^{\,3}}\cos\frac{\pi}{6}\,(t_s - 8{\cdot}57)$$
$$+\ 130{\cdot}4\ \frac{\sin 2\delta_s}{\rho_s}\cos\ \frac{\pi}{12}(t_s - 4{\cdot}46)$$

This is the theoretical amount, not allowing for any local retardation, or any influence of the weather.

The author has calculated this for a great variety of conditions of the variable quantities, and compared them with the results of observations, and the comparisons have always been satisfactory.

He gives comparative pairs of curves, one drawn by the tide-gauge, the other calculated by the formula, and the striking resemblance is at once appreciable by the eye. The coincidence would be still nearer if the influence of the small sidereal-time variations were added.

The mean amplitudes of the four chief oscillations are as follows:—

	Millimetres.
For the oscillation of twelve lunar hours ...	103·2
For that of twelve solar hours	55·
For that of twenty-four lunar hours	130·5
For that of twenty-four solar hours	62·4

The maximum amplitudes are:—

For the oscillation of twelve lunar hours ...	132·8
For that of twelve solar hours	60·9
For that of twenty-four lunar hours	272·2
For that of twenty-four solar hours	100·2

The author shows how the variable combinations of these several elements determine and account for the peculiar phenomena observed, and he explains in what particulars the circumstances at Fiume would appear to differ from those in other places, and to give rise to special phenomena peculiar to that locality.

He further devotes particular attention to the explanation of the singular daily retardation, which he states has also been noticed by M. Aimé on the coast of Algeria, although it had been erroneously ascribed by him to the effect of the wind. The real cause he shows to be the oscillations depending on sidereal time.

The non-periodical motions of the water are caused chiefly by variations in the direction and force of the wind, and in the barometer-pressure. The temperature of the sea rain, and storms, may have also some influence, but too slight to require investigation.

The author therefore confines his attention to the wind and the pressure of the air. In regard to the former, looking at the form and position of the Gulf of Quarnero, it is evident that southerly winds will force the water into the cul-de-sac towards Fiume, and so will raise the level, while northerly winds will tend to drive the water out of the gulf, and so lower the surface.

In regard to the barometer-pressure, it is pointed out that if the weight of the atmosphere at any given part of the sea differs from that at another part some distance away, there must be a corresponding difference in the level of the water; and this difference will be proportional to the specific gravities of the two fluids:—thus a difference in the barometer of one inch of mercury will cause a difference of level of about 13½ inches in the water.

The effects of these two influences are involved in various complications, but they are sufficiently proved by the records, and their amount is shown to be considerable.

The following facts shown in the records will give some general idea of the extent of the Mediterranean tides; we believe they are pretty much the same in all parts of the sea.

The highest water level known was on Dec. 26, 1870, being 0·870 metres above a certain datum point; the lowest was on Jan. 11, 1869, being 0·482 metres below the same point. Hence the greatest difference of level experienced was 1·352 metres, or about 4½ English feet.

The average daily variation of level was 0·583 metres, or nearly two feet English; the greatest daily variation was 0·825, and the least 0·259 metres.

The mean daily variation of level is the same, whatever be the absolute general level of the water; as is natural, seeing that the latter is influenced by local circumstances that have no effect on the attractions of the sun and moon.

The mean high and mean low water stand at equal distances above and below the average mean level.

The author modestly expresses the opinion that his own three years' observations are of too limited extent to determine fully the values of all the influences which affect the tides, and he recommends that before the investigation is carried further, accurate observations should be made at other points of the Adriatic Sea, in order that, by a combination of such data, the distinction between normal and exceptional phenomena may be more positively defined. No doubt such an extended inquiry would give results of great value to physical science, and M. Stahlberger's excellent example is not unlikely to stimulate others to co-operate in such an undertaking.

The book is well got up. It is written in the national language, but there is also given a translation into German, and the data, in the form of tables, are so full and complete as to enable anyone to verify, by his own examination, the conclusions arrived at by the author.

OUR BOOK SHELF

Cambridgeshire Geology; a Sketch for the use of Students. By T. G. Bonney, F.G.S., Tutor and Lecturer in Natural Science, St. John's College. Cambridge: Deighton, Bell, and Co., 1875.)

Mr. Bonney's short sketch of the geology of the neighbourhood of Cambridge will be a useful handbook to those students who wish to become practically acquainted with the geological features of the country round their temporary home. It makes no pretensions to be an exhaustive description, and happily is not written in a style suitable for cramming, but simply draws the attention of the careful reader to all the interesting points in connection with the geology of the district, and notices the various contributions to fact or theory made by previous writers, embodying many of Mr. Bonney's own observations. The first deposits described are the Oxford clay of St. Ives and the Elsworth rock, the true position of which latter is discussed; and then follows a notice of the coral reef at Upware, and the Kimmeridge clay at Ely. We have next a discussion of the coprolite and associated beds at Potton and Upware, which Mr. Bonney considers Upper Neocomian, and he thinks most of the fossils derived. After a short notice of the Gault comes a full discussion of the interesting questions connected with the so-called Upper Greensand. An admirable outline of its palæontology is first given, and the origin of its phosphatic nodules is then concluded to be analogous to that of flint, or what is here called concretionary action. With regard to its age, Mr. Bonney follows Mr. Jukes-Browne in considering it homotaxial with the chloritic marl, and a large part of its fossils derived from the Upper Gault. The chalk is dismissed with a very short notice, and an account of the Post Pliocene deposits concludes the sketch. These deposits are described under six divisions, the lowest being the true Boulder Clay. The most interesting of these is the "Fine Gravel of the Plains," which has yielded so many mammalian remains. Five appendices follow: on Upware sections, the Ely pit, the Hunstanton red rock, the water supply, and building stones of Cambridge. The second of these might well have been omitted, for though it refers to an interesting case of a large chalk boulder, we are now sufficiently familiar with such instances of huge transported rocks to make it waste of time to discuss imaginary systems of impossible faults to account for its presence in some other way.

Journey across the Western Interior of Australia. By Col. Peter Egerton Warburton, C.M.G. With an Introduction and Additions by Charles H. Eden. Edited by H. W. Bates. With Illustrations and a Map. (London: Sampson Low and Co., 1875.)

COL. WARBURTON well deserves any honours which he may have received; for the sake of increasing knowledge he has performed as bold a feat of travel as is on record. With his son, Mr. J. W. Lewis, two Afghan camel-drivers, and two natives, he set out on April 15, 1873, from Alice Springs, in E. long. 133° 53′ 14″, S. lat. 23° 40′, about 1,120 miles north from Adelaide, and travelled right across the centre of the Australian continent, reaching the western side in January 1874. Col. Warburton's narrative in the book before us consists of the record which he kept day by day of his progress. The party had sixteen camels, and were provisioned for six months. Experience has shown that to explore Central Australia camels alone are of any use, horses being totally unable to bear up against the universal scarcity of water, and the bristling spinifex stalks which cover the ground almost everywhere, and which cut their legs to pieces. Col. Warburton's journal, not long after the start, becomes a painful record of a daily hunt after water, a hunt which was often unsuccessful. During the greater part of the journey man and beast were in a chronic state of parching thirst. The country crossed over is as arid and desolate a wilderness as can well be conceived, consisting mainly of low sandy hills covered almost everywhere with the above-mentioned spinifex, occasionally varied by a salt marsh, a few hills, and rarely a few trees. Indeed, the whole country from 121° to 131° E. long. is one great sandy desert. Bustards, one or two species of pigeons, owls, rats, a small species of kangaroo, swarms of torturing flies and ants, were met with, the last-mentioned with painful frequency. Natives were also seen, and they proved perfectly harmless and generally shy, and some of them Col. Warburton describes as handsome and well made.

The general method of procuring water was to scoop out wells in the sand, and it was only at long intervals that suitable places occurred. The food supplies of the party were very soon exhausted, and they had for the greater part of the journey to live on roots, an occasional "wallaby" (small species of kangaroo), and on the camels which they were compelled to kill. Of the fourteen camels, only two reached the journey's end, some having been lost, some left behind as unable to move, and seven killed for food. The flesh of the latter seems to have been as tough and devoid of nourishment as leather, and by the time the party reached the welcome river Oakover they were all nearly on the point of starvation; latterly, Col. Warburton himself had to be tied on his camel's back. On reaching the Oakover, some of the party pushed on to the settlement for relief, which at last came, and Col. Warburton met with an enthusiastic reception everywhere from Roeburne to Perth and on to Adelaide. He has made a valuable contribution to our knowledge of Central Australia, and as the spirit of exploration seems to be thoroughly aroused in the colony, we may hope soon to have its geography at last filled up. The difficulties and dangers of Australian exploration are well known, and by forethought and organisation no doubt they might be successfully met. It seems doubtful whether any economic use can ever be made of the arid wastes of Central Australia, but a thorough knowledge of its natural history and geology would be of high value from a scientific point of view. All the expenses of Col. Warburton's journey, we should say, were generously borne by the Hon. T. Eden and Mr. W. W. Hughes, public-spirited Australian colonists.

The introduction occupies about one-half of this volume, and consists of a carefully compiled and most interesting *résumé* of Australian exploration from Eyre's daring journey in 1840 downwards; it adds much to the value of the work. Mr. Bates has discharged his editorial duties satisfactorily. A good portrait of Col. Warburton is prefixed, and the map gives one an excellent idea of the route as well as of the nature of the country. The other illustrations are rude but interesting. Altogether the volume is a valuable contribution to the history of Australian exploration.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Acoustic Phenomenon

PERHAPS the following description of a phenomenon in sound which I have frequently observed may be of some interest to a few of your readers:—

If an observer is placed a short way, say about eight yards, in front of a straight palisaded fence made with deals of about three inches in width and about six inches from centre to centre apart, so as to leave intervening spaces of three inches, and then gives a smart clap with his hands, or, what is better, with two flat pieces of wood, a peculiar echo is heard almost at the same instant.

The nature of the sound is neither that of a true musical note nor of an inflection; it appears to the ear to be somewhat intermediate to those, inclining more at the beginning, when well elicited, to a very high-pitched sound of the latter kind; it slides down until it becomes a distinctly audible musical sound at the end, if the fence is 80 or 100 yards long; with those dimensions a moderately quick ear can easily recognise the pitch of the final note to be near D on the fourth line of the treble clef.

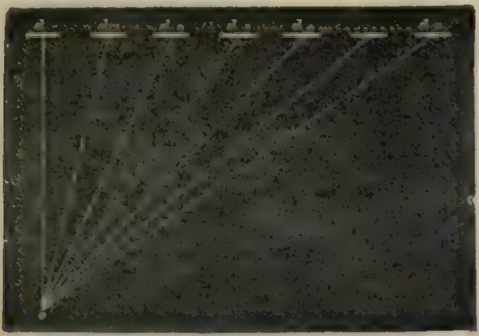
The phenomenon is caused by each board of the fence giving rise to a resonance; those aërial impulses succeed each other at constantly increasing intervals of time, and with such a degree of rapidity as to constitute a continuous sound of the kind which is here described. The vibrations will be seen, from the following diagram, to be neither isochronous like those of a musical sound, nor to vary in their periods in the same simple order as those of an inflection which is produced by sliding the bridge of a monochord while it is vibrating.

Let o be the position of the observer, and $d\ d_1\ d_2\ d_3$ &c. the boards of the fence.

Call the distance $o\,d = D$, and $d\,d = \delta$. Then by the common rule for right-angled triangles the distances of each board from the observer are respectively $\sqrt{D^2}$, $\sqrt{D^2 + \delta^2}$, $\sqrt{D^2 + 4\delta^2}$,

$\sqrt{D^2 + 9\delta^2}$; the reflected sounds which reach the observer will travel double those distances.

D $(D^2 + \delta^2)$ $(D^2 + 4\delta^2)$ &c., being integral quantities, and δ positive, the series will be an increasing one; hence the first impulse which is heard is that produced by d, and the last one that by d_n.



Twice the difference between any term and that which immediately precedes it will be the length of the sound-wave corresponding to that term, and the velocity of sound per second, divided by the wave-lengths, gives the relative pitches of the different impulses.

The wave-lengths corresponding to $d\, d_1\, d_2$ &c. are—

$$2(\sqrt{D^2 + \delta^2} - D);\ 2(\sqrt{D^2 + 4\delta^2} - \sqrt{D^2 + \delta^2});$$
$$2(\sqrt{D^2 + 9\delta^2} - \sqrt{D^2 + 4\delta^2})\ \text{\&c.} \qquad (1.)$$

And calling V the velocity of sound per second, we get the relative pitches—

$$\frac{V}{2(\sqrt{D^2 + \delta^2} - D)};\ \frac{V}{2(\sqrt{D^2 + 4\delta^2} - \sqrt{D^2 + \delta^2})}\ \text{\&c.}$$

Now, if the observer removes close up to the fence, the distance D becomes an indefinitely small quantity, or zero, and the series (1) for the wave-lengths becomes $2\sqrt{\delta^2}$; $2(2\sqrt{\delta^2} - \sqrt{\delta^2})$; $2(3\sqrt{\delta^2} - 2\sqrt{\delta^2})$; $2(4\sqrt{\delta^2} - 3\sqrt{\delta^2})$, &c., or 2δ, 2δ, 2δ, &c.; that is, the wave-lengths are all equal, and a musical sound is heard. In practice, an ordinary fence does not yield a sufficiently loud note to be easily heard in this case, but one made with posts having intervening spaces of about five inches gives a good result when one stands four or five feet from it, the note comes out almost perfect. By taking different values for D we have from series (1) a corresponding change of wave-lengths, so that if a row of persons are placed from o to d, each will hear a sound which is different in pitch from that heard by all the others.

It is perhaps needful to state that the sound which has been described is completely masked if there are houses or a wall a few feet behind it, or if the place of observation is a road fenced with palisades on both sides, two sounds are produced which interfere and confuse each other.

Glasgow ANDREW FRENCH

The Degeneracy of Man

THE numbers of NATURE for June and July last, which have lately reached me (vol. x. pp. 146, 164, 204 and 205), contain a correspondence on the subject of the degeneracy of man, in connection with which I wish to contribute a few remarks.

I have nothing to say on the original point introduced by Mr. E. B. Tylor. But, during my residence in the islands of the Pacific, I have given some attention to the general question of degradation or progression, as exhibited in the Polynesians. The result is, that I believe there are numerous indications of the degeneracy of these people from a higher social and intellectual level than that which they at present occupy. I could not give in detail, in this letter, the entire evidence on which this opinion is based; I will therefore briefly mention two or three indications only of this degeneracy which I have noticed.

The language of the Polynesians furnishes one of these. While there is much in it which shows a low moral tone, there are, on the other hand, many refinements (a large proportion of which are known to most of the present generation) which I do not believe could have been invented, or gradually developed, by the race in its present intellectual condition. Their old traditional stories, and their ancient poetry also, are so different from anything the present Polynesians are capable of producing, that I often think (your classical readers will please pardon the comparison) the relative difference, between the past and present, is as great as that between the intellect of the Greeks, in the period of the highest Attic culture, and those of the present century. I have often asked men of more than average intelligence, why their modern compositions are so inferior to many of the old ones. They invariably reply that the men of old were greater and wiser than those of the later generations.

The industrial and ornamental works of the Polynesians are all, I believe, of ancient origin. Their houses, their canoes (with one exception), their fine mats, the way in which they make their bark cloth, and even the patterns which they print on it, are all according to the traditional forms handed down from generation to generation. There is no originality. Invention is unthought of. Even now, when the influence of external civilisation is brought to bear with considerable force upon them, they adopt a new idea very, very slowly. If they had never been in a higher and more active intellectual condition, I cannot conceive how they could possibly have obtained the many comparatively excellent customs, the—in many respects—elaborate language, and the advanced social customs which were in their possession when first they became known to the civilised world.

I am well aware that absolute proof of the degeneracy of the Polynesians will not, by any means, render necessary the conclusion that degeneracy has been universal with the human race. Advocates of the progressive theory do not deny that some instances of degradation are to be found. In his "Primitive Culture" (vol. i. p. 34) Mr. Tylor says: "Of course the progression-theory recognises degradation, and the degradation-theory recognises progression, as powerful influences in the course of culture." Hence I present the indications of degeneracy above-mentioned as, at most, only a minute portion of the cumulative evidence which must be adduced indisputably to prove the degradation-theory of general application to the human race.

Apropos of this question I may add, that I often think much of the difference between (at least the more moderate) progressionists and degradationists is owing to the want of a clear definition of the term *civilisation* as used on either side. One appears to me to think chiefly of a *material civilisation*, while the other thinks mainly of a *moral civilisation*. I do not believe in the evolution of man from a lower form of life. But, notwithstanding this, I doubt whether the first man was *civilised* in the ordinary sense in which that word is now used. So far as a material civilisation goes, I take him to have belonged to the earliest stone age. But at the same time I feel the strongest conviction that he was, in point of moral civilisation, immeasurably in advance of a savage. It has often been said by advocates of the degradation-theory that no well-authenticated instance has ever been given of a savage who has, apart from external help, improved his condition. I believe this assertion to be true, notwithstanding Sir John Lubbock's "Cases in which some improvement does appear to have taken place," given in the appendix to his "Origin of Civilisation" (pp. 376-380). I do not deny the force of the reply to the above assertion, given by advocates of the progression-theory; viz., that it is almost impossible to *prove* that a savage race has, unaided by external influence, bettered its condition. But from personal observation of savage and semi-savage life, I feel almost certain that a real savage is utterly incapable of, in any way, raising himself. He lacks the sensibility which must serve as a fulcrum for the lever which is to lift him. Upon this ground alone, if I had no other reason for it, I should doubt whether man had, unaided, developed himself from a state of unmitigated savagery.

Upolu, Samoa S. J. WHITMEE

The Law of Muscular Action

IN NATURE vol. xi. p. 426, my esteemed friend Prof. Hinrichs does me the honour to comment on my paper published in NATURE, vol. xi. pp. 256 and 276.

He claims to have found that in lifting a weight w until exhaustion sets in, the number of lifts n is represented by the equation—

$$\left.\begin{aligned} n &= \frac{A}{B^w} \\ \text{or} \qquad \log. n &= \log. A - w \log. B_1 \end{aligned}\right\} \qquad (1)$$

where A and B are constants.

That the relation between n and w (the strength of the muscle remaining constant) is a logarithmic function was plainly indicated in the last paragraph but one in my second paper in NATURE, p. 277. In my paper in the *American Journal of Science*, Feb. 1875, p. 130, a formula was given at the close of the paper, p. 137, which is equivalent to Hinrich's formula (1), calling τ the time of exhaustion (or number of lifts), and s the strength of the muscle obtained with a dynamometer, and

$$\tau = a\,(s - \beta)^v \qquad (2)$$

where a and β are constants. If the dynamometer gave the real strength in kilograms, β would equal w. In the series published in NATURE, s was obtained in another way, there described, and β was zero (nearly); v is a function of the weight. So that Hinrichs' formula does not seem to differ essentially from (2). In giving this formula, I stated expressly that I did not wish to discuss this equation at present, as the constants had not been determined with satisfactory precision. I take this occasion to repeat that statement.

Another point to which it may be well to call attention is, that in exhausting the arm with heavy weights very little pain is felt. With light weights, however, the pain is very great.

Our knowledge of this whole subject is yet so fragmentary, and the subject itself is so complex, that we can only hope to represent our knowledge by empirical formulæ. The best service is to be rendered in the direction of careful experiment. I shall therefore devote a few years to the work outlined in my paper in the *American Journal of Science.*

Washington University, St. Louis, Mo., April 28 F. E. NIPHER

Physiological Effects of Tobacco Smoke

Is Dr. Krause (NATURE, vol. xi. p. 456, vol. xii. p. 14) acquainted with the manner in which cascarilla bark modifies the physiological effects of tobacco smoking? The addition of a few very small fragments of the bark can hardly be supposed to materially affect the amount of carbonic oxide produced; and yet, with such an admixture, the strongest tobacco may be smoked by a tyro without, in most cases, the production of the usual nauseating effects. Loss of appetite, thirst, vascular and nervous depression are sometimes produced if such a mixture is smoked in excess. On the other hand, if Dr. Krause's theory, that the nausea, &c., of tobacco smoking is due to the carbonic oxide inhaled, be admitted, the question is suggested whether some of the volatile products of burnt cascarilla bark are antagonistic in their physiological action to the gas in question? C. E. S.

OUR ASTRONOMICAL COLUMN

NEW VARIABLE STAR (?).—Mr. J. E. Gore, of Umballa, writes with reference to a star of about the 6th magnitude noticed on the 13th of January about 1° north, following θ Leporis, and not having found it in Harding's Atlas or in Lalande, or the B. A. C., he supposed it might be a new star. "It is of a reddish colour, and is in the same low-power field with, and about 25′ north of (a little preceding) the 7m. star Lalande 11778 . . . It is closely followed by two small stars which formed with it a curved line." From this description the star is evidently VI. 58 of Weisse's first Catalogue, observed by Bessel early in 1825, and estimated 6·7 magnitude, the small stars preceding it being Nos. 68 and 78 of the same hour. It is not found in D'Agelet, Lamont, or in any other catalogue we have examined, of previous date to that accompanying Heis's Atlas, where it is entered 6·7, but erroneously identified with VI. 78 of Weisse's second Catalogue, instead of VI. 58 of his first. (The large number of similar errors in Heis's references is a serious defect in a work otherwise of so much value.) Mr. Gore mentions that he had not remarked, up to the middle of April, any variation in the star's light, but it evidently requires further examination, and may yet appear on our rapidly extending list of variables.

THE BINARY STAR ζ HERCULIS.—If good measures of this star are obtained during the present season, we may expect to know the elements of the orbit with considerable precision. Dunér's results, founded upon measures 1826–69, will be the best so far published, but he did not regard them as definitive; they will no doubt be very useful in any further investigation, and for this reason are here subjoined:—

Peri-astron passage 1864·23

Node	45° 56′	Excentricity ...	0·42394
Node to peri-astron on orbit ...	250 50	Semi-axis ...	1″·223
Inclination ...	34 52	Period	34·221 yrs.

PETERS' ELLIPTIC COMET 1846 (VI.).—This comet, which was detected at Naples on the 26th of June, 1846, by Dr. Peters, now Director of the Observatory at Clinton, New York, was calculated by Prof. D'Arrest, and in a more complete form by the discoverer himself, who, in a memoir published in the Transactions of the Naples Academy in 1847, found the time of revolution 12·85 years, but with an uncertainty of ± 1·61 years; in a subsequent communication to Brünnow's *Astronomical Notices*, he gave elements for 1859, including the effect of perturbations of the planet Saturn, which, however, he shows to be liable to very considerable doubt, on account of the observations in 1846 being insufficient to fix the mean motion at perihelion in that year within narrow limits. It is to be remarked that in 1846 the comet appeared under nearly the most favourable circumstances possible for observation, and at the time of discovery the comet was distant from the earth less than 0·6 of our mean distance from the sun, yet Dr. Peters found it very small and faint, and unless the perihelion passage should happen to fall about the same time of the year as in 1846, it might be exceedingly difficult, if not impossible, to recover it. The only hope of doing so is in keeping a close watch in the late spring and early summer, upon those parts of the sky indicated with different suppositions for date of perihelion passage, say from May 15 to June 15, which are wholly in south declination, a circumstance that will render the assistance of observers in the other hemisphere very desirable. To give an idea of the comet's track in the heavens when the perihelion falls in May, we assume the 15th and 25th for the passage by this point of the orbit, and thus have the following positions:—

	In perihelion, May 15·0.			In perihelion, May 25·0.		
	R.A.	Decl.	Distance	R.A.	Decl.	Distance
May 15...	256°·5	50°·0 S	0·594	228°·8.	55°·8 S	0·600
„ 25..	256 ·5	42 ·2	0·552	231 ·1	48 ·4	0·561
June 4...	255 ·9	32 ·8	0·538	233 ·4	39 ·2	0·546
„ 14...	255 ·3	23 ·1 S	0·555	235 ·8.	29 ·4 S	0·564

The least distance between the orbits of the earth and comet is about 0·53.

Considering the uncertainty in the mean motion deduced from observation in 1846, it is quite within possibility that a perihelion passage may occur as late as the summer of the present year, and it may be worth while to institute a search upon that supposition.

MINOR PLANETS.—No. 26, *Circular zum Berliner Astronomischen Jahrbuch*, just issued, contains new elements and an ephemeris of No. 114, Cassandra, and corrected ephemerides of No. 71, Niobe, and No. 128, Nemesis. The period of revolution assigned to Cassandra for November 1872 is 1598·5 days. Several of this group are now adrift, the elements not having been determined with sufficient approximation to keep them in view. The planet found by Borrelly at Marseilles, 1868, May 29, and that detected by Pogson at Madras on November 17 in the same year, are thus situated; both travel beyond the limits of our ecliptical charts, which contain very small stars.

OUR BOTANICAL COLUMN

THE PANDANEÆ.—A fine series of Pandanus fruits has recently been received at the Kew Museum from Mr. John Horne, of the Botanic Garden, Mauritius

These fruits form the first consignment of a quantity collected in Mauritius and Seychelles by Mr. Horne for transmission to Kew, as material for the *Pandaneæ* in the forthcoming Mauritius Flora, and will form a valuable addition to the Museum collection. The fruit-heads of the *Pandaneæ*, like the cones of the *Piceas*, are very difficult to preserve entire except they be kept in fluid, and even then, if they are gathered too ripe the single drupes are apt to separate from the central axis. Those just to hand from Mr. Horne are the best set ever received at Kew, inasmuch as they appear to have been carefully selected and gathered before they were too ripe, wooden tallies with numbers *cut* in them firmly fixed upon each specimen with copper wire, and the whole sown up tightly in stout sacking or canvas and placed at once in rum. In this way the collection contained in five small barrels arrived in perfect safety at Kew, where the specimens, after being taken from the spirit and the canvas coverings cut away, were securely enclosed either in a network of thin copper wire or fine strong cord and gradually dried. We mention these facts because travellers and collectors too frequently send home specimens of Conifers, Cycad cones, or others of a similar nature simply rolled in paper or packed in sawdust; in the one case they dry and fall to pieces immediately upon opening, while in the other the sawdust absorbs moisture, and the fruit or cone simply rots and becomes quite worthless. Another advantage in sending woody fruits like the *Pandani* in fluid in the manner above described, is that they can be removed, dried, and mounted on wooden stands, by which they are more convenient for examination, and occupy much less space, and are manifestly more economical both for public and private collections than when preserved in large glass jars in alcohol. The collection, numbering some twenty-three heads of fruits, sufficiently illustrates the variety of form and size in the different species, the largest being some thirteen inches through, and the smallest not more than two inches. Mr. Balfour, who accompanied the Transit of Venus Expedition to Rodrigues, has also paid special attention to the *Pandaneæ*, and his collections, preserved, we believe in a similar manner, have recently arrived in this country.

SANTAL VERT.—Under the name of *Santal Vert*, or false sandal-wood, a dark green, close-grained wood, somewhat like *Lignum vitæ*, may occasionally be seen in wood collections. The origin of this wood is not generally known, but it seems to be the produce of an Euphorbiaceous plant, probably a species of *Croton*. The bulk is obtained from Madagascar, and some from Zanzibar. It is generally supposed, however, to be the produce of Zanzibar, probably on account of that from Madagascar passing by way of Zanzibar in course of transit to India, to whence it is mostly shipped, chiefly, it is said, for the purpose of burning the bodies of Hindoos, as it fetches a much lower price than the true sandal-wood. The wood of the *Santal Vert*, though small, is sometimes used in Mozambique for furniture. A species of *Croton* found by Dr. Kirk on the Zambesi produces a similar wood; indeed, it may be identical.

SOME RESULTS OF THE "POLARIS" ARCTIC EXPEDITION

IN a letter to the French Geographical Society, published in the March *Bulletin*, Dr. Bessels, the principal scientific member of the *Polaris* Arctic Expedition, rebuts some of the statements published by Mr. Tyson, and gives some of the scientific results which were obtained. The position of the Observatory, obtained from many varied observations, was 81° 38′ N. lat., 61° 44′ W. long., and thirty-four feet above sea-level. Many careful observations were made on the tides, in meteorology, magnetism zoology, botany, geology, and with the pendulum, in order to determine the force of gravity. Unfortunately, in the catastrophe which happened to the ship, many of the results of these observations were lost; nevertheless, enough was saved to afford a fair idea of the physical geography, the geology, the fauna and flora of the region visited. Dr. Bessels is preparing a detailed account of the results obtained, and we believe has given much valuable information for the use of our own Arctic Expedition.

The pendulum observations are specially precise and valuable. The magnetic observations are more complete than any hitherto made in the polar regions. The observations on declination were made every hour for five months, and during three days in each month every six minutes. The western declination was found to be 96°, and the absolute declination 84° 23′.

The observations on the tides were made with very great care, generally every hour, and for three or four weeks every ten minutes, in order to obtain the precise moment of the flux and reflux. High water occurs about every 12h. 13m.; the highest flux observed was 8 feet; the lowest reflux, 2·5 feet; mean of high and low tide, 3·8; mean of spring tide, 5·47; mean of neap tide, 1·83. Other hydrographical observations comprehend soundings, temperatures at various depths, and detailed observations on the specific gravity of the water.

After having entered Smith Sound, a current was observed running southwards, the rate of which varied from 1·5 to 5 miles. This current carried with it much driftwood, all the specimens of which seen by Dr. Bessels were coniferous, with very close ligneous layers, indicating that the specimens came from a cold climate.

The greater part of the meteorological registers were saved, embracing observations on the temperature of the air and on barometric oscillations, anemometric and hygrometric results, observations on terrestrial and solar radiation, on polar auroræ, and on ozone.

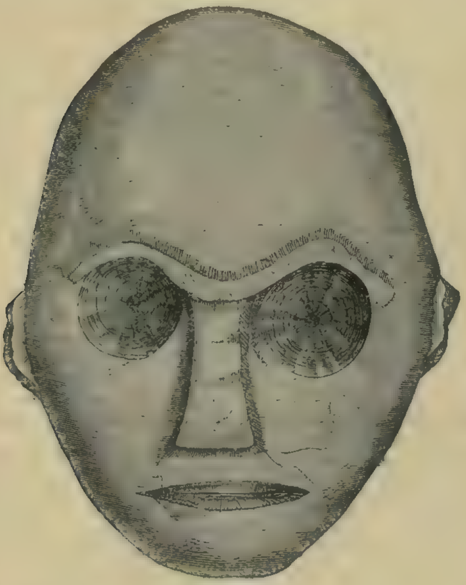
The fauna and flora of Hall's Land are very rich, but unfortunately nearly all the specimens collected were lost. Eight species of mammals were observed, twenty-three kinds of birds, fifteen species of insects, and seventeen species of plants. Of the mammals, *Myodes, spr.* (Pallas) and *Ovibos moschatus* (Zimm.) were found in West Greenland for the first time. The greater part of the insects are Diptera, of which one species is new.

Although the geological formation of Polaris Bay and its neighbourhood presents only Silurian limestone, containing few fossils, yet some very interesting observations were made. At elevations of 1,800 feet, not only was driftwood found, but also shells of molluscs (*Mya*, &c.), of species which still exist in the neighbouring seas. On examining some of the small lakes which abound in the region, marine crustaceans were found to be living in these fresh waters. This is certain evidence of the gradual elevation of the coast of this part of Greenland.

Wherever the country is not too steep, large numbers of erratic blocks are met with, of a kind quite different from the rocks on which they rest. There are blocks of granite, gneiss, &c., from South Greenland, and these blocks have evidently been borne, not by glaciers, but by floating icebergs; a proof that at one time the current in Davis Strait had a different direction, and passed from south to north. Dr. Bessels believes that Greenland has been separated from the American Continent in a direction from south to north.

ON THE OCCURRENCE OF A STONE MASK IN NEW JERSEY, U.S.A.

THE occurrence of stone "masks," such as the specimen referred to, has been somewhat frequent, in and about the "mounds" of the Ohio and Mississippi Valleys, but not eastward of these localities. Somewhat more elaborate carvings of the human face have been found in Western New York, figures of which are given in the Thirteenth Annual Report of Regents of New York State University. These may or may not be of identical origin with the western mound specimens. The specimen here figured is, I believe, the only one ever found in New Jersey. It is a hard sandstone pebble, such as are common to the bed of the Delaware River, above tide water. It measures six inches in length by a fraction over four inches in greatest breadth. It is concavo-convex, the concavity being shallow and artificial. The carving of the front or convex side is very rude, but shows distinctly that it has been done with *stone tools* only. The eyes are simply conical counter-sunk holes, rudely ridged, and just such depressions as the stone drills, so common among the surface relics of this neighbourhood, would produce. In the collection of stone implements from Central New Jersey, at the Peabody Academy of Salem, Mass., are several drills sufficiently large to bore as wide and deep depressions as the "eyes" of this mask. The nose is very flat and angular; the mouth merely a shallow groove. The ears are broken, but appear to have been formed with more care than any other of the features. The chin is slightly projecting.



The interest attaching to this specimen is, I think, twofold, and worthy of a moment's consideration. It is interesting from the fact of being found in New Jersey, a point much further east than the mound-builders have been supposed to reach, and there is no reason to suppose that the specimen was ever brought by white men from the west, and lost here. The circumstances connected with its discovery render such a supposition untenable. Its interest, otherwise, is in the fact (as I suppose it) of its being a true relic of the mound-builders. The mystery of this people has certainly yet to be solved, if, indeed, it ever can be, and the relationship they bore to the "Indian" determined. In the prosecution of my investigations into the "stone-age" history of the New Jersey Indians, I was continually struck with the great resemblance of the stone-implements found in New Jersey to those found in the western mounds. The specimens figured by Messrs. Squier and Davis, in the first vol. of Smithsonian Contributions, 1847, were all, or nearly so, duplicated by specimens I gathered in New Jersey; and up to the time of the completion of my second paper on the Stone Age of New Jersey (now in press), I needed but "animal pipes" and stone masks, such as the above, to make the duplication of the mound-relics complete. The occurrence of this specimen brings it to the one form of pipes, and that such have occurred in New Jersey is highly probable; but not having gathered such a specimen, myself, I assume that none have yet been found. It must be borne in mind, however, that as there are no mounds in New Jersey, animal pipes, if found here, must occur as surface relics, or in graves; which latter were, as a rule, very shallow. As New Jersey has been settled for about two centuries, it is probable that such animal pipes would be gathered up, when found, and soon again lost or destroyed, when ordinary "relics" would be overlooked. In this way, such animal pipes would have all disappeared, perhaps a century ago, when their value as archæological specimens was unknown. This, too, might account for the great rarity of such specimens as the mask here described.

CHAS. C. ABBOTT

Trenton, New Jersey, U.S.A., April 22

FERTILISATION OF FLOWERS BY INSECTS*

X.

Lilium Martagon.

C. SPRENGEL was the first to turn his attention to the structure of the beautiful flowers of this plant; † but he did not succeed either in observing insects visiting them or in explaining the contrivances by which they are cross-fertilised when visited by suitable insects. Since Sprengel's time nobody had, as far as I know, studied the manner of fertilisation of *Lilium Martagon.* It was, therefore, with great pleasure that, in Thuringia, I examined the structure of its flowers, and watched them in their natural habitat. The results of my observation were as follows.

Along the middle of each sepal and petal, beginning at its base and continuing throughout a length of 10-15 mm., is a furrow, which secretes honey, and whose margins converge and are bordered with reddish knobbed hairs, so close as to cover the open side of the furrow, and to convert it into a channel (*h*, Figs. 63, 64). The basal opening of this channel (*b*, Fig. 64) being closed by the base of a filament, the only way by which the honey is attainable is the small opening at the end of the channel (*e*, Fig. 64). This opening, as well as the channel itself, is very narrow, its diameter only a little exceeding 1 mm. No other insects except Lepidoptera are provided with sucking instruments sufficiently long and slender to be able to reach the honey concealed in these long and narrow channels; and from the flowers being turned downwards and the stamens projecting and slightly bending upwards, it is evident that Lepidoptera, when sucking this honey, cannot avoid dusting their under-side with pollen, and effecting cross-fertilisation as often as they fly to another

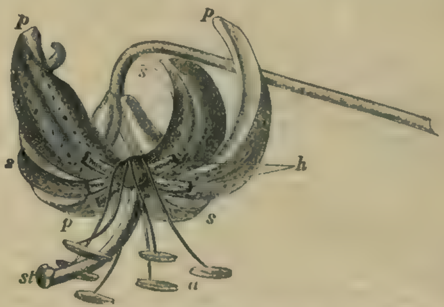


Fig. 63.—Flower of *Lilium Martagon* in its natural position and natural size.

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* Continued from vol. xi. p. 171.

† C. Sprengel, "Das entdeckte Geheimniss," &c., pp. 187-189

flower and bring their pollen-covered under-side first in contact with the stigma, which slightly overtops the anthers. The flowers of *Lilium Martagon* must consequently be considered as adapted to cross-fertilisation by Lepidoptera.

The colour of these flowers, dark reddish brown, with dark purple dots on the inside, is not very striking, and in the daytime they are but slightly scented, whereas during the evening they emit a very attractive sweet odour. Hence we may safely conclude that they are far more attractive to crepuscular and nocturnal than to diurnal Lepidoptera.

Thus far, in Thuringia, in July 1873, I had succeeded in explaining the separate peculiarities of the flowers; but in vain had I watched them repeatedly during the evening in order to surprise the fertilisers in the very act of fertilisation. But the hope I had failed in when making every effort to realise it, happened to be fulfilled a year later, quite unexpectedly. In the Vosges, returning from the Hoheneck, and passing the village Metzerall, July 5, 1874, towards the evening, I was struck with the sight of flowering plants of *Lilium Martagon* growing in a garden hard by, and a specimen of *Macroglossa stellatarum* flying round them and fertilising them.

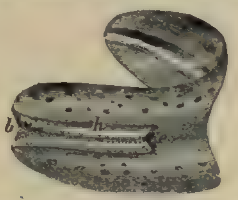

FIG. 64.—A single sepal or petal of this flower, magnified.

Freely fixed in the air by the rapid movement of his wings, this busy Sphinx inserted his long slender proboscis into the honey-channels of the sepals and petals, now of a single one, now of others of the same flower, and having done so immediately flew away to another flower. Yet, the flowers never being turned directly downwards, but somewhat inclined, all the honey-channels of any flower were never sucked by the Sphinx, but in every case only those of the uppermost sepals and petals. When sucking he always touched the stigmas and the anthers with his legs and under-side, and the latter ones were to be seen rocking and swinging. Thus, undoubtedly, the under-side of the Sphinx was dusted with pollen, and the stigma of the flower next visited, when first touched by the pollen-covered under-side, was cross-fertilised. A single Sphinx, with his vehement movements during a quarter of an hour, may easily visit and cross-fertilise plenty of flowers of *Lilium Martagon*. Nevertheless, self-fertilisation in many of these flowers will occur, where visits of Sphingidæ are wanting. For the stigma, by being bent upwards more decidedly than the anthers, comes frequently into contact with one or two of them; and C. Sprengel, who enclosed the yet unopened flowers of *L. Martagon* in a net, thus excluding all insects except some ants (and perhaps Thrips), was surprised to find that every capsule developed and matured its seeds.

Lippstadt HERMANN MÜLLER

NOTE ON THE HYRCANIAN SEA

THE resolution of the problems which are involved in the physical aspects of Western Turkestan, and which have offered so ample a scope for speculation, will probably be one of the earliest and most important consequences of the occupation of the banks of the Amú Darya by Russia. But, whatever may be the light which will thus be afforded to geographers, ethnologists, or historians, it is to be expected that the field of inquiry will widen and recede, in proportion as each step forward is made, along paths which have hitherto been shrouded in obscurity.

Among the observations which will demand, and which will most certainly fully repay, the greatest attention, are those which shall accurately determine the true rate of evaporation from the surface of Lake Aral. A meteorological observatory was established in June 1874 on the lower courses of the Amú, and its working will contribute much to a knowledge of the rate of local evaporation. It may be doubted, however, whether such observations as are recorded at Núkús will be of practical value for determining the desiccation going on in Lake Aral itself. In the absence of precise information we shall for some years be dependent upon data of doubtful trustworthiness, in regard to the aspect the lake may have presented at different epochs in past history.

Among such data there is an isolated observation which seems worthy of more attention than has hitherto been given to it. Between the years 1848 and 1858 Boutakoff found that the depth of water at the entrance of Abougir (the gulf at the south-west corner of Lake Aral, which is now entirely dry) had decreased by eighteen inches, or, in other words, at the rate of 0·05 yards per annum. This rate of decrease may possibly be not very exact; but it is approximately so, and may therefore serve, until better data are available, to draw some conclusions regarding the Aralo-Caspian Sea.

The chart of Lake Aral, compiled from the surveys of 1848-49, shows the waterspread to be about 24,500 square miles. The contour line drawn at a depth of twenty-four feet on this chart includes an area of about 18,300 square miles, *i.e.* the loss of surface is 6,200 square miles. For every yard of fall below its surface of 1848, Lake Aral, down to a depth of eight yards, loses a waterspread of 775 square miles. And since during the past twenty-seven years the surface has fallen $27 \times 0·05 = 1·35$ yards, the waterspread of 1875 will be $24500 - 775 \times 1·35 = 24500 - 1046·25 = 23453·75 = 23454$ square miles, say. The mean of the two waterspreads of 1848 and 1875 will be $\frac{24500 + 23454}{2} = \frac{47954}{2} = 23977$ square miles, or 74,271,155,200 square yards; and this quantity multiplied by 0·05 gives 3,713,557,760 cubic yards as the volume of water lost by Lake Aral yearly since 1848, or a loss of 120 cubic yards per second.

The supply poured into Lake Aral by the Amú and by the Syr can only be guessed at, since it has probably fluctuated during the past twenty-seven years. At the present time the combined volume afforded by those two rivers may be taken at about 2,000 cubic yards per second; and this estimate is probably not ten per cent. removed from the actual truth. The evaporation, then, from the lake must be assumed to have been, since 1848, $2000 + 120 = 2120$ cubic yards per second, from a waterspread of 23,977 square miles, or 74,271,155,200 square yards, which is equal to an evaporation of 0·0026 yards per diem = 0·0936 inches per diem, or thirty-four inches per annum.

The physical aspects of the shores of Lake Aral suffice to show that in very recent times its level has been at least fifty feet higher than that of to-day. With this increased depth the waterspread would be about 36,500 square miles, or 113,062,400,000 square yards. The daily evaporation from this surface at 0·0026 yards will be 293,962,240 cubic yards, or 3,400 cubic yards per second. There was therefore a time (and that a recent one) when Lake Aral received a supply of 3,400 cubic yards per second; and, indeed, of more than that quantity. The Russian knowledge of the country, handed down by the great map of the sixteenth century, informs us that a river flowed from the Aral to the Caspian. The geographical MS. of (according to M. Vámbéry) Ibn Said el Belkhi, notices in the early part of the tenth century, the opinion that the two seas communicated; and this communication could, and almost certainly did, take place in the following way.

The crest of the spur of the Ust Urt plateau, which formed the southerly limit of the now desiccated gulf Abougir, is about fifty feet above the present level of Lake Aral. Once filled up to that level, if the lake continued to receive more water than was evaporated from its surface, *i.e.* more than 3,400 cubic yards per second, an overflow would take place into the country now traversed by the channel called Uzboy, which has a gentle slope to the south of less than four inches per mile.* It is probable that the lands stretching from Uzboy westwards to the foot of the elevations encircling Karaboogas would have been flooded. Perhaps at this high level Aral may have discharged at its extreme north-western point also, and have flooded the country stretching round the northern foot of Ust Urt. On the north, it may have topped the low transverse ridge which now divides the northern and southern drainage. And if, in addition, the level of the Caspian was at that time some few feet higher than it now is, its waterspread would have advanced to meet the overflow from Aral, and Ust Urt and its narrow southern spurs, which run along the east shore of the Caspian, would have been isolated among marshes and shallow water. The classical geographers would thus have had ample grounds for the description they have handed down to us of the Sea of Hyrcania, as well as good reason for giving but a single name to the waterspread of the sea, since the separation of its basin from that of Aral would have become evident only after the fall of the level of this lake.

Until the separation became evident, this Aralo-Caspian Sea would have presented all those aspects which history tells us it has had. As the level gradually fell in Lake Aral, the inundated ground would become dryer; and in the first century of our era, as reported by the Chinese, the banks of the "Western Sea" would have been surrounded with great marshes. It may be doubted whether the Palus Oxiana of Ptolemy and the Oxian Marsh mentioned by Ammianus Marcellinus should be placed in this locality; but there is more probability that the Sinus Scythicus of Mela is identical with Lake Aral and its former southern marshy appendage, of which Uzboy is the axis.

The waterspread of such an Aralo-Caspian Sea would have added an area of about 70,000 square miles to the limits of the Caspian of to-day; and the evaporation from such a surface would have absorbed a supply from the rivers then feeding Lake Aral of about 7,000 cubic yards per second; in other words, a volume of water three-and-a-half times greater than that discharged by the mouths of the Amú and the Syr together at the present time.

If it be considered that at this epoch the greater, if not indeed the entire volume of the Oxus passed directly westwards into the Caspian, the difficulty is somewhat increased in finding an answer to the important question, where the large volume of water mentioned came from?

However, it is very probable that the Tchuy and the Sary Su discharged at that time into Lake Aral, instead of losing themselves, as they now do, in the sand. The Kenderlik of the great Russian chart, as well as the Demous, the Baskatis, and the Araxetes of the classics, together no doubt with many other minor streams, have disappeared in these countries, though their waters formerly would have fed Aral. Their disappearance seems to have been contemporaneous with the desiccation of the Oxus branch of the Caspian, at an epoch when those irruptions of Mongol hordes from the north-east were taking place, which swept away early Central Asian civilisation, and which subsequently caused the destruction of the Greco-Bactrian Monarchy. Whether this ruin of ancient social culture was accompanied by the destruction and wreck of a system of hydraulic works which were necessary for the cultivation of the soil, is a question whose answer possibly bears very nearly on the causes of the desolation which Nature now wears in the countries of Western Turkestan.

HERBERT WOOD

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* See NATURE, vol. xi. p. 231.

THE COMMONS EXPERIMENTS ON ANIMALS BILL

THE Bill for the prevention of cruelty in experiments on animals, made for the purpose of scientific discovery, prepared and brought forward by Mr. Lyon Playfair, Mr. Spencer Walpole, and Mr. Evelyn Ashley, is of a very different character from that introduced by Lord Hartismere in the House of Lords and commented on in our last issue (NATURE, vol. xii. p. 21). In it no legislative interference is proposed in the case of operations performed for scientific purposes under the influence of anæsthetics, provided that the insensibility is continued throughout the experiment; immediately after which the animal is to be killed if it has been in any way seriously injured. In the case of operations performed on animals in which it is impossible to employ anæsthetics, it is proposed that those who wish to conduct them shall be required to obtain a license authorising their undertaking them, to obtain which from the Secretary of State a certificate must be produced signed by one at least of the following persons, viz.: the President of the Royal Society, or the Presidents of the Royal Colleges of Physicians or Surgeons of London, Edinburgh, or Dublin; and also by a Professor of Physiology, Medicine, or Anatomy in Great Britain. In the case of the applicant being himself one of the just-named professors, or an authorised lecturer on the same subjects, such a certificate is not to be required, but in its place his application would have to be signed by the registrar, president, principal, or secretary of the university or college with which he is connected. The license requires renewal each five years, except in the case of professors, with whom it lasts during their tenure of office. It extends to any person assisting the holder of the license, provided that the person assisting acts in the presence and under the direction of the holder of the license.

The penalty proposed for any contravention of the Act is a fine not exceeding fifty pounds, or imprisonment for a term not exceeding three months.

The whole tenour of this Bill is so much in accordance with our own feelings that we can say nothing against it. Physiological operations on the lower animals, when conducted under the full influence of anæsthetics, cannot shock the most sensitive-minded; and supposing the Bill passes, it will be in the power of all to see that nothing of a painful nature is undertaken. No definition of what is meant by pain is given, it is true; and the only improvement we can suggest is that one be added which prevents the employment of curare as an anæsthetic until its pain-killing power is demonstrated.

BALLOONING AND SCIENCE

THE number of aëronautical ascents in France has been greatly increased since the *Zenith* catastrophe attracted public notice to aërial questions. On Sunday, the 9th of May, not less than three different balloons went up in different places.

These ascents took place at Ivry, close to Paris, at 5.30, at Nantes at 5.40, and at Algiers at 3.45. In the three cases the balloonists experienced a change in the direction of the wind, varying greatly with altitude. The general direction of the Nantes balloon was south-east. The Paris balloon had a less velocity with a greater number of circuits, having ultimately run a distance of ten miles in two hours. The greatest velocity of the air was in close vicinity to the earth; this is an indication of a special current probably produced by the warming action of the sun on the solid surface exposed to its rays. These special currents, although somewhat dangerous in making a descent, die out at an altitude of a few hundred feet. The superficial current experienced in the Algiers ascent was running eastwards, and was really a marine current produced by the vicinity of the sea. A peculiarity of this ascent was the presence of a fog, observed at a certain distance above the earth, in air which was coming from the water and had been rendered humid when crossing the Mediterranean Sea. The thermometer, which was only 23° centigrade on the ground, ascended gradually to 25°, and gave 38° and 40° when the balloon had traversed the fog. The maximum observed was 43° at a small altitude.

Clouds do not always prevent the rays of the sun from warming the atmosphere below to a certain extent. In an ascent executed at Avignon (Vaucluse) on the 6th, the thermometer exhibited a warming effect of 5° C., although the balloon had not passed through the clouds, which were at an elevation of more than 4,000 feet.

I do not think we should depend entirely for our knowledge on such points to elaborately organised ascents. As much of our knowledge of the sea has been obtained from the log-books of trading vessels, so by a little good management on the part of aëronautical societies, much important information concerning the atmosphere might be collected from balloonists who make ascents either for purposes of pleasure or profit.

W. DE FONVIELLE

NOTES

M. ANDRÉ, the head of the French Transit Expedition to New Caledonia, has arrived in Paris. His account of the observations will be read to the Academy on Monday week. Dr. Janssen is not expected to arrive in Paris before the 10th of June.

DR. HOOKER was present at Monday's sitting of the Paris Academy of Sciences, of which he is a correspondent in the section of Botany. M. Frémy, the president, noticed the fact, and Dr. Hooker was warmly received by all present.

WE remind the Fellows of the Royal Society of the Reception on the 26th inst., at their rooms in Burlington House, to which they have been invited.

INFORMATION has been received at the Admiralty, by telegram, stating that the *Challenger* will not visit Vancouver Island as intended, but will proceed to Nagasaki, Honolulu, and Valparaiso. Letters should be addressed to Honolulu until the middle of July, and after that date to Valparaiso.

THE French Aëronautical Society has elected for its president M. Paul Bert, the physiologist, who recently organised the fatal *Zenith* expedition. M. Bert has never ascended in a balloon, and has refused several times to do so. M. Tissandier, who had experienced so narrow an escape in the *Zenith*, was appointed one of the vice-presidents.

THE Spectacle Makers have resolved to confer the freedom of their Company on Sir George B. Airy, K.C.B., F.R.S., &c., Astronomer Royal.

WE learn from the Australian papers that an expedition for the exploration of New Guinea is being fitted out by Mr. Macleay, a wealthy citizen of Sydney. Important scientific results are expected to be gathered by this expedition, and Mr. Macleay is worthy of praise for devoting his wealth to so important an object. Notwithstanding that so many explorers are and have been on the island, there is a great deal yet to be done ere we can have anything like an adequate knowledge of its people, its physical condition, and natural history. We hope Mr. Macleay's expedition will attack a part of the island not hitherto explored, and add much that is new and valuable to our knowledge of a country so interesting in itself and in relation to the past of Australia.

THE Swedish Arctic Expedition to Novaya Zemlya, which will start at the beginning of next month from Tromsöe, will be occupied first with botanical, geological, and ethnological inquiries in the southern part of Novaya Zemlya, and then advance along the west coast to the northern point, which it expects to reach about the middle of August. Thence it will go to the north-east to explore this still quite unknown part of the Polar Sea, and then southwards to the mouths of the Obi and the Jenisei, where the country is geologically very interesting. If the ice creates no obstacles, Prof. Nordenskjold will here quit the vessel, and go in a boat up the river, to return home afterwards by land.

THE February number of the *Proceedings* of the Asiatic Society of Bengal contains the President's Address. Colonel Hyde, among other important and interesting topics, refers to the scheme for providing Calcutta with a Zoological Garden, which, through various untoward circumstances, has been hitherto frustrated. The value of such an institution in Calcutta, if put on a rational footing, both to the European and native communities as well as to science, is undoubted, and we hope with Colonel Hyde that the scheme will have the attention both of the Imperial and Local Governments. Indeed, we believe that the Lieutenant-Governor of Bengal has taken up a piece of land suitable for the purpose. The question of the establishment of a Zoological Garden at Calcutta has been before the public and the Asiatic Society from time to time during the last thirty-five years, and it does seem strange that the capital of India should have been so long without such an institution.

ANOTHER subject referred to by the President in the above address is that of earth-current measurements, a committee in connection with which has been appointed at the suggestion of Mr. Schwendler. Considering the very great importance of research in this direction, "there can be no doubt," to quote the Calcutta *Englishman*, "that the Government of India would be fully justified in promoting the undertaking, just as it has assisted the observations of the Transit of Venus, of eclipses, and of meteorological phenomena."

AN unprecedented contest has taken place at the Académie Française in filling the seat vacated by the recent demise of M. Guizot. After four scrutinies, the election was postponed for six months. M. Dumas, the perpetual secretary of the Academy of Sciences, was a candidate, and had as an opponent M. Jules Simon, the former Minister of Public Instruction, an influential member of the Academy of Moral Sciences. But a third candidate, M. Laugel, the scientific reviewer of the *Temps*, and the private secretary of the Duc d'Aumale, having been proposed by his patron and voted by him throughout the four scrutinies, no result could be obtained, the nominations being only made on an absolute majority. M. Laugel has written a few philosophical essays on scientific matters, and is a man of knowledge, but is not known except to a limited circle of friends.

IT is said that thirty young Chinese belonging to influential families are expected very shortly in Paris, where they are to be educated. They are under the care of a French naval officer, who, having joined the Chinese navy, has been appointed Director of Fow-chow Arsenal.

M. LEVERRIER has presented to the Academy of Sciences the observations on the transits of small planets made during the last three months at Greenwich and at Paris: the two Observatories are working conjointly in this department. Observations, limited to those asteroids which are near their apposition, have been made on twenty-two small planets; but the weather was so bad at both Observatories that only sixty-nine observations are recorded, sixty at Paris and nine at Greenwich. Generally the proportion is greater in favour of English observers, but the clouds were dreadfully against them during the last quarter.

We are informed that Mr. Chadwick, M.P., brought with him from California, on his recent visit, a box of superior Californian silkworm eggs. We understand that he is anxious to distribute them to anyone having a supply of mulberry-leaves and wishing to cultivate them. The eggs have been entrusted to Mr. Loose, the secretary of the Chamber of Commerce, Macclesfield, from whom small quantities can be obtained on application. Mr. Loose has also prepared a few simple instructions for feeding and keeping the cocoons.

The number of candidates at the recent General Examination for Women at the University of London was thirty-five. Of these, twenty have passed, viz., seven in honours, twelve in the first, and one in the second division.

Prof. J. Sachs, of Würzburg, is engaged in the preparation of a History of Botany, which is expected to be ready for publication in the course of the present year.

In answer to a request made by the Paris *Figaro*, M. Dumas has given the following details of the alleged effective remedy against Phylloxera :—All remedies discovered up to the year 1874 had the disadvantage that while destroying the obnoxious insects they did considerable harm to the vine itself; the experiments lately made with sulpho-carbonate of potash were, however, perfectly successful, as they do not effect the vine in the least; they were made by M. Milne-Edwards, Du Chartre, Blanchard, Pasteur, Thénard, and Boulay, in different wine-growing districts, particularly in the environs of Avignon, Cognac, Montpellier, and Geneva. The sulpho-carbonates are strewed on the ground, the next rain helps them to penetrate the soil, and the Phylloxera are completely destroyed by them. These salts at present are still rather expensive, but in the districts where the Phylloxera have only just appeared a very small quantity is sufficient, and it is hoped that if Government undertakes a larger production of the salts, the price will be considerably reduced.

The new Reptile House in the Jardin des Plantes, Paris, has sustained some heavy losses. A large turtle died from the shot it had received many months ago when captured in the Atlantic Ocean, and a large serpent from a wound inflicted by a rat. The rat having been offered as living food, resisted violently, and bit his adversary so deeply that he died a few days afterwards. The warders in the picturesque Reptile House will probably be more cautious in future in showing visitors the spectacle of Ophidians running after their food.

We are glad to say, however, that the above heavy loss will be to a considerable extent compensated, as the Jardin des Plantes will receive in a very few days a Boa more than eight yards in length, which has just arrived at Havre. We believe it takes a goat or a sheep to appease its appetite at one time.

A Geographical Society has been established in Roumania under the patronage of the present Prince. A great want has been felt of such an institution, not a single original work having been written by Roumanians on the geography of their native land. All geographical school-books are merely translations of foreign works, and are all full of errors, even as regards Roumania.

A correspondent of the *Pharmaceutical Journal*, Mr. G. C. Druce, suggests whether *Saxifraga tridactylites* is not a carnivorous plant. He states that the glands on the leaves present a very similar appearance to those of *Drosera*, and secrete a viscid fluid on being irritated. In a large number of plants which he examined he found the *débris* of some insect attached to the leaves.

The second of a series of industrial exhibitions projected by the Manchester Society for the Promotion of Scientific Industry was opened at Cheetham Hill, Manchester, on Friday last. The present show has been arranged for the special encouragement of appliances for the economy of labour.

A large deposit of amber has been discovered in the Kurische Haff, near the village of Schwarzort, about twelve miles south of Memel. It had been known for many years that amber existed in the soil of the Kurische Haff, from the fact that the dredgers employed by Government for the purpose of clearing away the shallow spots near Schwarzort that impeded navigation had brought up pieces of amber, which, however, were appropriated by the labourers; and no particular attention was paid to the matter till recently. Some speculative persons, reports our Consul at Memel, made an offer to the German Government, not only to do the dredging required at their own expense, but also to pay a daily rent, provided the amber they might find should become their own property. The proposal was accepted, and the rent fixed at twenty-five thalers for each working day. The dredging was commenced by four machines, worked by horses, which have increased in number and efficiency till eighteen other dredges and two tug-boats, with about 100 lighters or barges, employing altogether 1,000 labourers, are now engaged in the industry. The ground covers an area of about six miles in length, and a yearly rent of 72,200 thalers is paid by the company to the Government.

A new species of a new genus of serpents, collected by Lieut. Wheeler's expedition in Arizona during the field season of 1874, has just been identified and named by Prof. E. D. Cope. It is called *Monopoma rufipunctatum*. The rostral shield of this new genus resembles that of *Phimothyra*, and the lateral head shields those of *Cyclophis æstirus*. It is, however, more like *Eutænia* in general character. This is a very interesting discovery.

For some time past the United States steamer *Fortune*, commanded by Commander F. M. Green, has been engaged in the Gulf of Mexico and the West Indies, under the direction of the Hydrographic Office, in determining the latitude and longitude of certain points connected by submarine telegraph. Those so far decided are Panama, Aspinwall, Kingston, Santiago de Cuba, and Havana, in each of which places a portable observatory and astronomical instruments were set up, and numerous observations made. The longitudes were determined by the exchange of telegraphic signals, and the latitudes by the zenith telescope observations. During the course of this work numerous soundings were taken, and a very extensive series of specimens of the sea-bottom brought up. These have been submitted to Prof. Hamilton L. Smith, of Hobart College, Geneva, New York, who finds among them many new species, and others previously considered as very rare, and scarcely met with since their description by Prof. Bailey and others.

The Manchester Field Naturalists' Society issues a very modest Report for 1874, from which it seems that the Society is doing quiet, steady, satisfactory work; "the working members of the Society have steadily extended their knowledge, and latent taste for Natural History has been fostered and developed." This Society is a field club, and during 1874 had twelve successful excursions, interesting reports of which are given by Mr. F. J. Faraday.

Another Manchester society, and one that really deserves honourable mention, is that known as the Manchester Scientific Students' Association. From its Annual Report for 1874 it is evident that the Society does much good work in which a comparatively large proportion of the members take part. Their frequent excursions are not mere pleasure-trips, as, besides a leader, a lecturer is appointed, who generally takes up a particular subject and illustrates it from the observations and gatherings of the day. During the winter meetings are held for the reading of papers, many of which seem of considerable value. This Society was formed for the practical study of science, and on the whole this object appears to be well kept in view.

THE Cambridge Board of Natural Science Studies announce that applications by members of the University desirous of availing themselves of the facilities for study at the Zoological Station at Naples during the ensuing season, are to be sent to Mr. Foster, Trinity College, on or before the 20th of October.

AN appeal is made on behalf of the widow of the late Dr. Beke: that lady, it seems, having been left in very straitened circumstances. It is proposed to utilise the Beke Testimonial Fund for this purpose, and additional subscriptions are requested to be paid to Messrs. Cox, Biddulph, and Co., Charing Cross, or to Messrs. Robarts, Lubbock, and Co., Lombard Street.

WE would draw the special attention of our readers to an excellent new quarto work, abundantly and beautifully illustrated, on "The Marine Mammals of the North-western Coast of North America, together with an account of the American Whale-Fishery," by Capt. Charles M. Scammon. It is published at San Francisco by J. H. Carmany and Co. The figures of the characteristic attitudes of the different species of seals, as well as of the whales, in their native element and otherwise, are far superior to any we have ever seen, having all been evidently taken from the life. The volume is dedicated to the memory of Louis Agassiz.

PROF. SHALER has published a memoir upon the "Antiquity of the Caverns and Cavern Life of the Ohio Valley," in which he endeavours to show the period at which the animal life, so characteristic of Western caverns, received its first expression. He sums up his researches in the following propositions:—1. The extensive development of caverns in the Ohio Valley is probably a comparatively recent phenomenon, not dating further back than the latest Tertiary period. 2. It is doubtful whether there has been any extensive development of cavern life in this region before these caverns of the subcarboniferous limestone began to be excavated. 3. The general character of this cavern life points to the conclusion that it has been derived from the present fauna. 4. The glacial period, though it did not extend the ice-sheet over this cavern region, must have so profoundly affected the climatal conditions that the external life could not have held its place here in the shape we now find it, but must have been replaced by some Arctic assemblage of species. Under the circumstances, it is reasonable to suppose that most, if not all, the species found in these caves have been introduced since the glacial period. 5. We are also warranted by the facts in supposing that there is a continued infusion of "new blood" from the outer species taking place, some of the forms showing the stages of a continual transition from the outer to the inner form.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, presented by Capt. Damm; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mr. John Gordon; a Sloth Bear (*Melursus labiatus*) from Ceylon, presented by Mr. W. D. Wright; two Antarctic Skuas (*Lestris antarctica*) from the Kerguelen Islands, presented by the Rev. A. Eaton; a Proteus (*Proteus anguinus*) from the Adelsberg Caves, presented by Capt. R. F. Burton; a Persian Gazelle (*Gazella subgutturosa*), two Coatis (*Nasua nasica*), born in the Gardens; two Wapiti Deer (*Cervus canadensis*) from North America, an Ocelot (*Felis pardalis*) from South America, a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, deposited.

ARCTIC MARINE VEGETATION

NOW that another expedition is about to sail for the Arctic regions through Davis's Straits, it is thought that some notice of the magnificent flora of the shores of Greenland may prove interesting. An essay on this subject,* written in Swedish, by Professor Agardh, the celebrated Swedish algologist, is now before me, but as it is too long for insertion in these pages, I will endeavour to condense as much of it as possible into an abstract.

During the Swedish Expedition to Greenland in 1870, a collection of Algæ was made on the Greenland coast, between Disco Island and Sukkertoppen, some degrees to the southward. These Algæ were afterwards examined by Professor Agardh, and in the essay above mentioned he gives us the result of his examinations, and some exceedingly interesting observations upon the characteristics of the marine flora of this Arctic district. It is not only the more or less numerous species which give to the marine vegetation in different zones a different character, but it is the abundance or scarceness of Algæ, their divarication in a greater or less degree from the common form and aspect, their great size, the multitude of individuals, and so on, which give a very variable appearance to the seaweed-grown shores of different seas.

As in the northern region of the pine-tree, there are but few species, while the masses of forest are formed of an immense number of individuals which grow near together; so with regard to the northern marine flora, the principal portion of which is found to possess a general character, consisting of a few similar species, but, as before mentioned, of an immense number of individuals. Nearest to high-water mark are the species of Fuci; below them are the Laminariæ (Tangles, or seaweeds); these crowd on every rock and stone, and to each of them is attached its peculiar parasitic species. Occasionally, other species, belonging to the northern marine flora, stray into calm bays, inclosed caverns, or are carried away by strong currents. Compared with the weed-covered shores of Southern Europe, the uniformity of aspect on these Arctic shores is very great, and the number of species occurring there fewer than those of our own coasts. The principal characteristic of the vegetation of the colder seas is the gigantic size of the species of which it is composed, and this is especially the case with regard to the northern Algæ. *Laminaria saccharina* and *L. digitata*, *Himanthalia*, *Alaria*, *Scytosiphon filum*, &c., on our own coast, give but a feeble indication of what the more Arctic regions in this respect exhibit. When it is known that the Mediterranean and warmer seas contain some few species which from their great size are never found in Herbaria, one can understand how difficult it must be to find specimens suitable for Herbaria among the Arctic species. Professor Agardh lays great stress upon the importance of collecting specimens of these plants in all stages of their growth, and points out the great similarity to each other of young plants of different species, which makes it extremely difficult to discriminate the different species in the young state. The numerous examples, of all ages, brought home by the Swedish expedition, and especially those laid down in salt, could thus be examined in a fresh state, and enough of them might be dissected for the more accurate determination of these large-growing species. As Professor Agardh has referred here to salting down the Algæ, it may be as well to mention that in another publication he has stated that the best way of preserving Algæ is by the following process. In a cask or other convenient vessel put a layer of salt, then a layer of Algæ; then another layer of salt, then another of Algæ, and so on until the cask is full. Algæ thus preserved are found to be almost as fresh as when first taken out of the sea.

If in the extreme north the phanerogamous flora is characterised by dwarf forms, so do forms of an opposite character prevail in the marine vegetation of the Arctic regions. To a certain degree the aspect of the magnificent Arctic marine vegetation depends upon the common large-growing Laminariæ, which constitute a considerable and characteristic portion of it. Laminariæ are also found in the Southern Ocean, and there are even other large Algæ, as, for example, the species of Iridæa, in the North Pacific, which have much larger dimensions in colder oceans than have analogous species in the warmer seas. So, also, the great number of species of Laminaria in the Arctic seas is an indication

* Bidrag till kännedomen af Grönlands Laminaricer och Fucaceer af J. G. Agardh, inlemnadt till K. Vet. Akad. den 27 Sep. 1871. (Stockholm, 1872, P. A. Norstedt and Söner.)

that if these prevail the number of other species is relatively less. While, on the other hand, only one species of Laminaria with an entire, and one with a laciniated frond, is found on the Swedish coast, there are on the coasts of Spitzbergen and Greenland at least five species of Laminaria. The *L. cuneifolia* of Greenland is about the same size as *L. saccharina*; but *L. longicruris*, one of the commonest Algæ of Greenland, is very large; the stalk, which is sometimes many ells[*] long, bears a lamina (frond) of equal size. Some specimens had been seen by Prof. Agardh, which, including both stem and frond, were eighty feet long. Ruprecht mentions an Alaria from the Sea of Okhotsk, the frond of which was about the same breadth as that of the common European form, which had a length of more than fifty feet. From Spitzbergen comes another species of this genus, whose frond is as much as one ell in length and about three ells long; and also another species several ells long, with a stem as thick as a finger. But it is especially in the north part of the Pacific, on the North American coast, that the richness of the Laminarian forms and their great size are most conspicuous. The species of Alaria, Arthrothamnus, Thalassiophyllum, Agarum, and Nereocystis together constitute such a magnificent marine flora, that one feels a difficulty in forming an idea of the smaller representatives of the same group which are found in other seas. *Nereocystis Lutkeana* has a stalk 270 feet in length, when it swells into a bladder that bears a tuft of fronds which are quite twenty-seven feet in length. In the Antarctic seas the analogues are to be found, the Durvillæa, and Lessonia of Cape Horn, Ecklonia of the South African coast, the species of Macrocystis, &c., are well-known examples of the large Algæ which are found there.

It is perhaps less surprising that a rich marine flora should appear on the coast of Spitzbergen wherever a considerable branch of the water of the Gulf Stream follows the coast, and in proportion receives a higher temperature and a greater degree of saltness. But in Greenland it may be otherwise. Cold currents are said to flow along the west coast of Greenland upwards, as well as on the opposite coast of America downwards.[†] During a considerable portion of the year the sea appears to be frozen along the coast, and even during the summer months drift ice is reported to be continually seen in the open sea. Under such conditions, although a marine vegetation of large size appears there, it may be assumed that an ice-cold or nearly ice-cold sea by no means prevents a great development of Algæ, where the other conditions necessary for their growth are found. One is tempted to believe that the great abundance and size of the marine flora on the coasts of the colder seas, on the one hand, and on the other the richness of the open seas in Diatomaceæ, are in some measure the cause of the abundance of animal life which prevails in these regions, and which, in the regularity of its limits, may afford a hint to the expeditions for carrying on the whale fishery that every year employs thousands of vessels. "It has been remarked," says Ruprecht, "that the northern boundary of the large sea animals is found where the coast is most bare of Algæ;" and Maury ("Physical Geography of the Sea") remarks on the superior flavour of fish from the colder waters, and the greater excellence of the principal fishery grounds of the world, which are all situated in the colder waters.

In direct opposition to what occurs on the Greenland and Spitzbergen coast, Ruprecht states that the whole coast of Behring's Sea north of the Aleutian Islands is almost entirely without marine vegetation; an astonishing statement, as not only on the Aleutian Isles, but also on the American coast to the south of them, the marine flora is rich and is developed on a grand scale. Ruprecht's statement that the whole Arctic sea of Siberia, eastward from the Gulf of Kara to Behring's Sound, is almost entirely without marine vegetation, is almost open to doubt, since Prof. Agardh possesses specimens of two Algæ in good preservation which were taken near the mouth of the Lena, and Ruprecht himself mentions another Alga which was found in Behring's Sea. Should it be ascertained that while the rocks of the Arctic Sea, wherever they have been examined, namely, in Norway, Spitzbergen, Greenland, and the coasts of America, present, through the number of individuals and their great size, a peculiar marine vegetation, while, on the other hand, eastward from the Gulf of Kara the sea should be found to be very poor as regards its flora, or even desitute of these large Algæ, perhaps one might under these circumstances form an opinion that the Baltic Sea was one of the former gulfs of the Arctic Ocean, and at a later period was separated from it; hence great interest attaches to the study of the Algæ of the Baltic Sea. The character of extraordinary scarcity of Algæ, which according to Ruprecht characterises the Arctic Ocean, also prevails in the Baltic Sea, where long ranges of rocks, broken like those of the Atlantic into bays, and apparently well adapted to harbour a rich vegetation, are entirely bare of vegetation, while the rocks and rock-pools on the western coast are crowded with Algæ. The stunted representatives of marine Algæ that most generally appear in the southern and western parts of the Baltic Sea may perhaps have come at a later period from the west, after the Baltic was united with the Atlantic.

More accurate information relative to the Algæ and their alleged scarcity in the Siberian Sea and Behring's Sound are still wanting, but *à priori* one is scarcely entitled to assume that the Algæ in these localities should differ materially from the uniform character of gigantic size which seems to distinguish the vegetation of the other Arctic Sea. On the other hand, that the Baltic Sea, as well in respect of the number of individuals as of their development, is in direct opposition to the vegetation in the other northern sea, is undeniable. But the Baltic Sea is in a peculiar state. It is an enclosed sea, into which large fresh-water rivers discharge themselves, and a freezing sea, ice-covered during a considerable part of the year, in a great degree prevents evaporation. Both these circumstances may cause the Baltic to be considered almost as a fresh-water basin, into which salt water flows from the sea almost entirely through the Kattegat and more south-westerly parts, and in the deep water retains some perceptible degree of salt. The influence of the salts on the growth of Algæ is at present but little understood, but that they have great influence cannot be doubted. The Algæ which appear in the Baltic cannot be said to indicate a high northern or north-eastern origin. They seem to be the Algæ of the Kattegat in a dwarf form. Some few species of Algæ appear to be peculiar; but in this case they do not prove that the Baltic was once a gulf of the Arctic Sea.

It has been already remarked that a scarcity of forms and abundance of individuals is a characteristic of the marine vegetation of the northern ocean. Nevertheless it must not be concluded from the scarcity of forms which prevails in every separate locality, and of which a few species of each constitute the principal masses of marine vegetation, that the same species prevail everywhere. We should then fall into the error of the older botanists, who thought that they recognised in foreign Algæ many well-known forms of the European flora, which outwardly bear a great resemblance to each other. With regard to the northern Laminariæ and Fucaceæ, it may yet be shown that there are analogous—if not identical—species, which appear in different localities, and that the species resembling each other in aspect, also in their *habitat* resemble each other, and thus constitute representative species. The circumstance that at first one does not perceive the difference between species bearing similar names from different localities, is but weak evidence of the identity of the forms which under the same names were supposed to prove that all these so-named European species actually appeared on the coast of Australia; although we might justly allege this fact as a proof of changes which might have broken the former connection between the seas, and so prevented migration from taking place at the present time. So soon as accurate examination is made, important variations are observed to exist between many species which pass under similar names, and some doubt may be entertained, not only whether they constitute entirely different species, but even whether they do not sometimes belong to entirely different genera.

Such representative species appear in many, and in perhaps most genera; but in Laminaria and Fucus there are some analogous forms which are very similar to the eye; there being in each genus two principal forms only, while each possesses many species which bear a great resemblance to each other. The similarity is, in reality, here so great that many were for a long time considered, and many more may probably even henceforth be considered, as modifications of the same species.

The difficulty of characterising the species of Laminaria is really very great, not only on account of the great resemblance between them, but also because the species change their aspec during different periods of their development, and this more frequently in an analogous manner. During the first period they are so like each other that it is almost impossible to separate one from the other the younger forms of the most dissimilar species. They all begin with a short stalk and an undivided frond (lamina); then the stalk continues short in some, and lengthens considerably in others; in some the lamina continues undivided; in others it is cloven. But it is especially to be observed that this lamina, whether undivided or cloven, is variable in most species. Thus, all are at first small and extended in length, with a more or less wedge-like base; but the wedge-like base becomes heart-shaped and even kidney-shaped in some; in others it retains a wedge-like form throughout its whole state of development. Most species periodically change their lamina; with the change the new lamina becomes larger and broader than the old one. The young lamina is thin; in colour rather inclining to green than to light brown; in different species the lamina is at a later period thinner or thicker, and with a different tint of colour. The fructification appears in different species not only in different parts of the lamina, but the sori extend in different directions, although they do not seem to assume precise forms. The characteristics of species must therefore be judged, not from the peculiarities of appearance, but by the whole development of the plant, the differences of which are with difficulty comprehended, unless the species throughout their whole range of growth be accurately compared with each other. Considering that certain characteristics are scarcely perceptible except when the plants are in fresh condition, and that collectors are contented with preserving portions or incomplete specimens only, we cannot wonder that the species of Laminaria should be confounded with each other.

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[*] A Swedish ell is equal to two feet.—M. P. M.

[†] In the narrative of the North German Expedition it is stated that on the east coast of Shannon Island, lat. 75° 29′ N., drift-wood, identified as alder (*Alnus incana*, L.) and poplar (*P. tremula*, L.) was washed ashore, thus plainly showing that the drift-wood of N.E. Greenland comes originally from N. Siberia; whence, driven into the sea by the strong currents, it floats in a westerly direction north of Spitzbergen, and is carried on until it reaches Greenland, where it takes a southerly course. See vol. ii. p. 537.—M.P.M.

Greville had named a Laminaria from the coast of Africa, *L. pallida*, from a modification in its colour. Younger forms, in which the colour was less evident, or the lamina not yet cloven, were referred by many algologists sometimes to *L. digitata*, sometimes to *L. saccharina*. But between these northern species and that of the Cape, lies an ocean which it is difficult for a Laminaria to pass. Although the characters which separate *L. pallida* and *L. digitata* are not more important than those which separate *L. digitata* from *L. stenophylla*, it must, nevertheless, be considered that *L. pallida* is a distinct species.

L. longicruris is the most common as well as the largest of the Greenland Laminariæ. It is the representative on their coast of *L. caperata*, a native of Spitzbergen, no specimens of which have been seen from Greenland, neither has *L. longicruris* yet been found at Spitzbergen. From Greenland *L. longicruris* spreads down the American coast as far at least as the forty-second parallel, and one specimen is reported from the Bahamas. Portions of this species have been cast ashore on the coasts of Norway, Ireland, and Scotland. In Gunner's "Flora Norvegica," a form is mentioned under the name of *Ulva maxima*, which Agardh considers to be *L. caperata*; the same form has also been found on the north coast of Scotland.

The Berggren collection also contained a great number of examples of Laminaria that, by Dickie (Algæ from Cumberland Sound, in Linn. Soc. Journ. vol. ix. p. 237) and by Croall (in Brown's "Flora Discoana," Trans. Bot. Soc. Edinb. p. 459), was called *L. saccharina*. Prof. Agardh considers the above-mentioned plant as identical with his *L. cuneifolia*. He states that he has never seen a specimen from Greenland of *L saccharina* as it appears on our coast. *L. cuneifolia* is an example of a species which is found near Greenland and also in the northern part of the Pacific. The Alga described by Ruprecht under the name of *L. saccharina v. lessoniæfolia* may be a smaller form of the same species. Specimens from Newfoundland and Scotland have been seen, which may belong to the same species. [*]

Of *L. solidungula* there are specimens from Ritterbank and Jakobshavn. This species seems to have a wide range in the Arctic sea, appearing at Spitzbergen, Greenland, and in the northern parts of the Pacific, if, under this species, is to be accepted some specimens with disciform roots described by Ruprecht.

In the same collection is a new species with laciniated frond, named *L. atro-fulva* from its dark colour, which distinguishes it from every other species, in all stages of its growth. Excepting *L nigripes*, it is the only Laminaria from Greenland with a laciniated frond. Neither Dickie nor Croall mentions it in their lists of Algæ. In a note to the Flora Discoana it is mentioned that in another collection *L. digitata* was found. From such a statement one may, nevertheless, be unable to determine which Laminaria with laciniated lamina was here referred to. That *L. digitata*, so common on the European and Spitzbergen coasts, should not be found in Greenland was so much the more singular, that it was thought to be common at Newfoundland, and is stated by Harvey to appear on the American coast as far south as Cape Cod. Postel and Ruprecht also mention it as existing in the North Pacific, but perhaps the specimens seen belong to other species. *L. Bongardiana*, with which *L. atro-fulva* most nearly agrees, is said to have a canaliculated stem, by which it is easily separated from the Greenland species.

Of *L. dermatodea* there is only one specimen in this collection. It is probably rare in Greenland. This species is found at Newfoundland, Spitzbergen, and Norway.

L. Fascia is included in the Berggren collection, but is not met with at Spitzbergen.[*]

A Greenland specimen, called *Scytosiphon filum*, was in a state of preservation too imperfect to be determined.

The most beautiful and characteristic species of the Greenland marine flora are, undoubtedly, those of Agarum, a genus which belongs also to the northern part of the Pacific. The Greenland species extend down the North American coast and that of Newfoundland, but not a fragment of this genus has as yet been found on the Spitzbergen and European coasts. It appears to be common in Greenland. The Greenland species vary in the breadth of the costa and the closeness of the holes with which the frond is pierced, but Agardh knows of no other difference, and refers all the specimens to one species, namely, *A. Turneri.*

Among the Laminariæ, included in the collection, few are of greater interest than the form of Alaria taken in Sukkertoppen in great abundance and of all ages. Hence Prof. Agardh has been able to characterise the different Greenland species of Alaria, which are as follow:—*A. esculenta*, *A. musæfolia*, *A. Pylaii*, *A. membranacea*, and *A. grandifolia.*

Next to the Laminariæ the Fucaceæ form the most considerable part of the Berggren collection. They consist chiefly of the more Arctic forms, brought home from Spitzbergen, with some differences. Of the forms common on the north coast of Europe (*Fucodium canaliculatum*, *Fucus serratus*, *Halidrys siliquosa*) which have not been found on the coast of Newfoundland or America, there are not any examples in the Greenland collection. Of these, *F. serratus* only is found at Spitzbergen, but this differs from the true European form. With *F. serratus* may be compared *F. edentatus* of Newfoundland. *F. canaliculatum* was compared by Harvey with *F. fastigiatum* of California. Analogous species probably represent each other in different localities. Of *Fucodium nodosum*, some examples, taken from different localities, are found in the Greenland collection.

Fucus vesiculosus, so common along the European coast even up to the extreme north of Norway, is absent, or at least very scarce, at Spitzbergen, but is one of the commonest of the Greenland species. It is found there both with and without vesicles. Besides *F. vesiculosus*, the collection contains numerous examples of *F. evanescens*, J. Ag., *F. Miclonensis*, and *F. filiformis*, which grow together, and in the same locality as *F. vesiculosus*, which is distinguished from the others by its stout consistence and by its drier surface, while the others give out more mucus. It is also easy to separate extreme forms of *F. evanescens*, *F. Miclonensis*, and *F. filiformis*, but among the abundance of specimens brought from Greenland intermediate forms appear, so that it is often difficult to decide the boundary between these species. When extreme forms lie together, *F. filiformis*, so different in its aspect from *F. evanescens*, is without doubt much more nearly related to *F. evanescens* than to *F. distichus*, with which it has long been confounded and considered identical.

Among the Greenland collection is one which differs from any that Prof. Agardh had seen, but which agrees most nearly with *F. filiformis*, although it is separated by fixed characters from all the species previously received. The smallest forms come nearest to *F. balticus*, like that forming globular vesicles which probably float the plant with ease into deeper water. It has been named *F. divergens.*

The fact that the species of Fucus, more than those of various other genera, appear to be formed upon a single type, contributes naturally to the common opinion that the genus has few but much-varying species. In describing the Greenland forms, Prof. Agardh has endeavoured to show that besides the difference in form, deviations also occur which ought to be retained as characteristics. In a preceding memoir he had stated that the differences noticed by other algologists in the antheridia and spores being formed in the same or in separate receptacles may possibly be explained thus: namely, that in different seasons the receptacles differ in this respect. Should such an explanation prove to be erroneous, it will undoubtedly be seen that it is these differences, more than others, that deserve to be considered as the characteristics of species.

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[*] Near Walrus Island, lat. 74° N., great quantities of marine plants, chiefly consisting of a large Laminaria, were washed up by the ice and the tide, or were lying in hollows. See Narrative of North German Expedition, vol. ii. p. 518.—M. P. M.

[*] In the narrative of the German Arctic Expedition (vol. ii, p. 345) *L. Phyllitis* is stated to have been found all along the East Greenland coast among and under the ice. This is the first time I believe that this Alga has been reported from so high a latitude. It was accompanied by *Desmarestia aculeata.*--M. P. M.

The reader who wishes for further information relative to the species of Algæ inhabiting the Arctic seas is referred to the list of Arctic Algæ in Harvey's Ner. Bor. Americana, and to Dr. Dickie's List of Algæ obtained in Cumberland Sound (Journal of Linn. Soc. vol. ix.) Perhaps also some of the Algæ collected by Dr. Lyall on the north-west coast of America, thirty-two of which had not been found elsewhere, may extend to the Arctic Sea. See Harvey's List of Algæ, collected by Dr. Lyall, Journ. of Linn. Soc. vol. vi.

MARY P. MERRIFIELD.

SCIENTIFIC SERIALS

American Journal of Science and Arts, April.—The principal contents of this number are: The history of Young's discovery of his theory of colours, by Alfred M. Mayer. The aim of this paper is to give extracts from Newton, Young, and Wollaston, which embody the early literature of Young's celebrated theory of colour, and to furnish a history of the steps by which he was led to the adoption of what is now known as Young's theory of colour-sensation.—A re-determination of the constants of the law connecting the pitch of a sound with the duration of its residual sensation, by Alfred M. Mayer. This article refers to a previous article of October 1874 on the same subject. Since then, Madame Seiler (who assisted Helmholtz) and Dr. Carl Seiler have spent considerable time in re-determining the durations of the residual sonorous sensations, using Mr. Mayer's apparatus. From their experiments he has found the law given before as $D = \left(\frac{53248}{N + 23} + 24\right)\cdot0001$ requires to be modified to $D = \frac{3\cdot2}{N + 31} + \cdot0022$, where $D =$ the durations of the residual sonorous sensation corresponding to N number of vibrations per second.—On the action of the less refrangible rays of light on silver, iodide, and bromide, by Carey Lea. The result of 160 very concordant experiments shows that AgBr and AgI are sensitive to all the visible rays of the spectrum. AgI is more sensitive than AgBr to all the less refrangible rays and also to white light. The sensitiveness of AgBr to the green rays was materially increased by the presence of free silver nitrate. AgBr and AgI together are more sensitive to both the green and the red rays than either AgI or AgBr separately.—On the Silurian age of the Southern Appalachians, by F. H. Bradley. First portion (to be continued).—Spectroscopic examination of gases from meteoric iron, by Arthur W. Wright. On the supposition that meteoric iron has received its hydrogen and other gases from the sun or some other body having a similar atmosphere of great density, it seemed probable that a spectroscopic examination might reveal the unknown gaseous elements assumed to be present in the solar corona. Only negative results were obtained. But the fact incidentally observed of the varying character of the oxygen and hydrogen lines in the presence of hydrogen, and the near coincidence of two of them with prominent coronal lines, with the possible coincidence of a third line, goes to show that the characteristic lines in the spectrum of the corona, so far from indicating the presence of otherwise unknown elements, are simply due to hydrogen and the gases of the air, oxygen and nitrogen.—On the duplicity of the principal star of Σ 1097, by S. W. Burnham.—The original notes under the head of Scientific Intelligence are: Progress of Geological Survey of Canada, 1873–74; the genera Opisthoptera (Meek, 1872) and Anomalodonta (Miller, 1874); the Gulf of Mexico in the Miocene time.

Der Naturforscher, Nos. 1 to 5, 1875.—This part contains many papers reprinted from other journals, besides several original contributions. We note the following:—On the physiological action of amyl nitrite and the causes of blushing; investigations made by Herr Wilhelm Filehne, who found that amyl nitrite acts upon that part of the brain which is also acted upon when the individual has the feeling of shame and blushes. The most interesting part of the paper is the description of the effects of amyl nitrite upon animals; accelerated breathing and palpitations were the result, evidently similar to the physiological phenomenon in man. In the latter case, whether produced by the ether or by psychic emotion, the phenomenon is exactly the same.—Report on the Crustacea observed on board the *Challenger* between the Cape of Good Hope and Australia, in the Antarctic seas, by Willemoes-Suhm.—On the ascending currents of air in our atmosphere, by J. Hann.—On the finer structure of the electric organs of fish, especially of the species Torpedo, Malapterurus, and Gymnotus, by F. Bol.—On the point of combustion: a lecture delivered by A. Mitscherlich before the Chemical Section of the Association of Naturalists at Breslau.—On the fossil Cetacea of Europe, by J. F. Brandt.—On the diatoms of the coal age, by F. Castracane. The author succeeded in proving the existence of diatoms in a piece of Lancashire coal; it was powdered finely, and burnt in a stream of oxygen. The residue was treated with nitric acid and chlorate of potash, and then washed. The species he found were all sweet-water species, with the exception of a Grammatophora, a little Coscinodiscus, and an Amphipleura, and comprised the following:—*Fragilaria Harrisonii*, Sm.; *Epithemia gibba*, Ehrbg.; *Sphenella glacialis*, Kz.; *Gomphonema capitatum*, Ehrbg.; *Nitzschia curvula*, Kz.; *Cymbella scotica*, Sm.; *Synedra vitrea*, Kz.; and *Diatoma vulgare*, Bory.—On the Chætopoda of the Atlantic, by E. Ehlers; account of the results of a collection made on board the *Porcupine* in 1869.—Studies on the diameter of the sun, by P. Rosa. These studies were published after the death of the author, by Fathers Secchi and Ferrari, and contain many interesting details which are well worth the attention of astronomers.—On the absorption spectra of some yellow vegetable colouring matters, by N. Pringsheim. The result of these investigations seems to be that these colouring matters are merely modifications of chlorophyll, and that there exist numerous modifications of this substance, from the brightest yellow to the darkest green.—On the influence of the concentration of blood upon the motion of the blood-corpuscles.

SOCIETIES AND ACADEMIES

LONDON

Physical Society, May 8.—Prof. Gladstone, F.R.S., president, in the chair.—Mr. Crookes, F.R.S., exhibited and described some very important experiments on attraction and repulsion resulting from radiation, which he has recently submitted to the Royal Society, and of which an account has already been given in this journal (vol. xi. p. 494). It is unnecessary therefore to describe them at length, but it may be pointed out that the most beautiful of the instruments is one which Mr. Crookes calls a radiometer. It consists of four arms suspended on a steel point resting in a cup so that they are capable of revolving horizontally. To the extremity of each arm is fastened a thin disc of pith, lampblacked on one side, the black and white faces alternating. The whole is enclosed in a glass globe, which is then exhausted as perfectly as possible and hermetically sealed. Several of these instruments varying in delicacy were exhibited, and experiments made showing the influence of light and heat of different degrees of refrangibility, and in proof of the law of inverse squares, &c.—The President, in expressing the cordial thanks of the Society, referred to Mr. Crookes' statement that the repulsion was proportional to the length of the vibrations, and asked whether at the red end of the spectrum there was an abrupt termination of the action, and a gradual diminution towards the ultra violet.—Mr. Walenn inquired as to the action of the magnet and of different axes of crystals in causing repulsion.—Prof. Woodward made some observations with reference to the manipulation.—Prof. Guthrie paid a graceful compliment to Mr. Crookes' work, and observed that researches might be divided into two classes; those in which the value of the work outweighed the merit of the author, and those in which a result of comparatively trifling significance is the outcome of years of patient labour. He expressed a strong conviction that Mr. Crookes' research had, in an almost unparalleled degree, both elements of greatness.—Mr. Crookes stated, in reply to Dr. Gladstone's question, that the glass envelope of the radiometer must be taken into account in considering the action of the rays of different refrangibility, and further, that the increased effect due to red light may have been in part due to the concentration of rays of low refrangibility which attends the use of glass prisms. A diffraction spectrum might give a different result. He added that when a ray falls on a surface capable of motion, which reflects it, very little work is done, but if the surface quenches the ray, motion is produced. He then thanked Prof. Guthrie for his kindly remarks.—Prof. Cornu, of the Ecole Polytechnique, described his recent experiments on the determination of the velocity of light. He gave an account of the method of Foucault, and exhibited the complete apparatus, including the arrangement of mirrors for multiplying the distance traversed between the two reflections from the revolving mirror (NATURE, vol. xi. p. 274).—Prof. Adams, vice-president, mentioned that M. Cornu had contributed in no small measure to the success which had attended the formation in France of a society closely corresponding to our British Association, and assured him that the Physical Society felt grateful for his presence, as he could well understand the difficulties with which the early days of such a society are beset.—M. Cornu stated, in answer to a question of Prof. G. C. Foster, that he objected to the revolving mirror method, because the distance to be traversed by the light was very small, and because the path of the ray lay through a vortex of air produced by the rapid revolution of the mirror.

Royal Horticultural Society, April 7.—Scientific Committee. A. Grote, F.L.S., in the chair.—A communication was read from W. Wilson Saunders, F.R.S., describing a diseased condition of young poplars planted on the sides of roads in East Worthing. The disease seems sooner or later to be fatal to the tree, for he had not seen one tree attacked of which there seems any chance of recovery. The trees are from twelve to eighteen feet high, and with stems varying from five to seven inches in diameter. The disease is most apparent in large, rough, open wounds about the commencement of the lower branches, and on the stem; but upon closer examination symptoms of the disease will be found all over the tree, even to the tops of the branches. The disease seems to show itself at first by a longitudinal fissure in the bark, which fissure is nearly straight and but of little depth, having its lips slightly elevated and reflexed. At first the fissure does not penetrate the whole depth of the bark, but, gradually deepening and extending in length, the wood becomes exposed. This continues until the wood is quite exposed, and in a branch of two years' growth the disease assumes the appearance of a long open wound, exposing much of the wood which the growth of the bark partially covers up. Tracing the progress of the disease further, side fissures will be seen producing the same results; and these fissures, running one into the other, break up the bark until occasionally the disease extends all round the branch. When a branch gets diseased, the portion above the wound dies. The disease is often slow in progress, particularly when on the main stem, large open wounds then appear, of the same character as those on the branches, exposing much of the wood, but having the surrounding bark, although diseased and cracked, in a healthier state.—Mr. M'Lachlan referred to a note in the report of Lieut. Carpenter, of the American Geological Survey, in which it was stated that the Colorado Potato Beetle was distributed by means of seed potatoes, and that its absence in Utah and other parts of California was to be attributed to the fact that it has not yet been necessary to import seed potatoes.—Mr. Hemsley sent a turnip with a cavity in the interior of the root nearly filled by leaves growing from the crown downwards and inwards.—Prof. Thiselton Dyer exhibited under the microscope a portion of the plasmodium of *Æthalium*, showing the "streaming" movements of the protoplasm of which it is composed.

General Meeting.—W. Burnley Hume in the chair.—The Rev. M. J. Berkeley commented on the objects exhibited, including a group of species of *Drosera* and *Drosophyllum* exhibited by Messrs. Veitch.

April 21.—Scientific Committee.—Andrew Murray, F.L.S., in the chair.—The Chairman remarked that from his own observation there could be no doubt that the Colorado Potato Beetle was perfectly able to live in the climate of Canada.—Mr. Edmonds sent from the Gardens at Chiswick House a basket of *Peziza lanuginosa*.—Dr. Masters exhibited shoots of peach-trees which had been killed owing to having been thickly painted with colza oil.—Mr. Wilson Saunders communicated a note on a monstrous condition of the early St. John's Cabbage. When the bed of cabbages was about at its best, a long, warm, very dry period was succeeded by much rain. The sudden impulse given to vegetation by this soon caused the solid heads of the cabbage to burst, and in a few days a series of smaller, well-shaped, rounded, compact heads were formed from the central axis of growth, closely touching each other, and backed up by the leaves of the original head, which remained green and full of sap. The number of these smaller heads varied from three to six in each cabbage.—Prof. Thiselton Dyer read an abstract from the *Sitzungsbericht der Gesellschaft Naturforschender Freunde zu Berlin* for Nov. 17, 1874, in which an account was given by Magnus of the production of graft hybrids in the potato by Reuter, the chief gardener at Potsdam, in 1874. He used the white long Mexican and the dark grey black kidney, both of which sorts had been introduced from America by the Novara Expedition. A wedge-shaped piece of the former, bearing an eye, was grafted upon the latter. The graft hybrids exhibited an intermediate character in form between the parents. They were broader and thicker than the long thin Mexican, longer than the black kidney. One of the potatoes also exhibited a blending of the colours. The two ends were red, and the middle zone a greyish yellow. The dark grey colour of the black kidney is produced by the intense red sap in a layer of cells covered by the corky rind. In a subsequent communication Magnus mentioned similar experiments which had been made by Dr. Max Heimann, and communicated to the botanical section of the *Schlesischen Gesellschaft* in the *Sitzungsbericht* for Nov. 19, 1872. Magnus described similar results obtained by Dr. Neubert, of Stuttgart, by herbaceous grafts of the stems.

General Meeting.—W. Burnley Hume in the chair.—Prof. Thiselton Dyer commented on the objects exhibited.

Anthropological Institute, May 11.—Col. A. Lane-Fox, president, in the chair.—Mr. Moncure D. Conway, M.A., read a paper on Mythology. He maintained that the evolution of mythology was the reverse of what the facts of physical evolution might suggest; it was not from beneath upwards to higher things, but rather from the grand in nature that the human mind had arrived at the association of mystical meanings with the stock and stone, plants and animals, which figured so largely in popular mythology. Sacred animals were consecrated as symbols of the higher phenomena. Flowers and plants derived their potency from connection with solar or lunar influences, still represented in the belief that to be healing they must be gathered at certain holy times or at certain phases of the moon. It was also maintained that the gods were personifications of power, and unmoral; they were gradually divided into good and evil, the demoniac powers being for a long time not diabolical, but personifications of hunger, thirst, and the dangers and impediments of life. The idea was combated that men had ever worshipped purely evil powers. The legend of Eden was held by Mr. Conway to be inexplicable by Semitic analogues. In India were found the myths of serpent-guarded trees and the apple of immortality, and the curse on the serpent which had puzzled theologians was explained by the theory of transmigration.—A paper by Rev. A. H. Sayce, M.A., was read, on Language and Race. The author held that the fallacy of language as a sure and certain test of race is one to which few modern philologists would commit themselves. There was no assertion which could be more readily confronted with history, or, when so confronted, more clearly be demonstrated to be false. Society implied language, race did not; hence, while it might be asserted that language is the test of social contact, it might be asserted with equal precision that it is not a test of race. Language could tell us nothing of race. It did not even raise a presumption that the speakers of the same language were all of the same origin. It was only necessary to look at the great States of Europe, with their mingled races and common dialects, to discover that language showed only that they had all come under the same social influences. Race in philology and race in physiology meant very different things.—Mr. A. W. Franks, F.R.S., exhibited an inscribed wooden gorget from Easter Island.

Entomological Society, May 3.—Sir Sidney Smith Saunders C.M.G., president, in the chair.—The President exhibited male specimens of *Stylops*, taken by himself in the pupa state, on *Andrena atriceps*, at Hampstead Heath, on the 6th, 9th, and 17th April last. Mr. Enoch, who had been there on the 6th at an earlier hour (between nine and ten o'clock) had been still more successful, having captured 17 males, one of which, however, was taken after 2 P.M. The President drew attention to the remarkable difference observable in the cephalothorax of the females in these specimens, as compared with those met with on *Andrena convexiuscula*, and remarked on the importance of not confounding the species obtained from different *Andrenæ*, *Stylops Spencii* having been described from *A. atriceps*, while *S. Thwaitesii* had been described from *A. convexiuscula*. Mr. Smith believed that eventually a great many species would be found to inhabit this country, and that as many as a dozen different species would probably be found on the genus *Andrena* alone, independently of *Halictus*.—Mr. M'Lachlan read an extract from a report made to the Royal Society, on the Natural History of Kerguelen's Island, by the Rev. A. E. Eaton, who was attached as Naturalist to the Transit of Venus Expedition to the island (NATURE, vol. xii. p. 35). Nearly all the insects were remarkable for being either apterous or with greatly abbreviated wings. Mr. M'Lachlan said that the theory as to the apterous condition of the insects was that the general high winds prevailing in those regions rendered the development of wings useless; and Mr. Jenner Weir remarked that the apterous condition was correlated with the fact that plants under similar circumstances were apetalous and self-fertilising; and hence it was supposed that the existence of winged insects was unnecessary.—Mr. C. O. Waterhouse exhibited a *Chelifer* which he had discovered under the elytra of a *Passalus* from Rio Janeiro.—Mr. C. O. Waterhouse also exhibited a drawing of a Neuropterous insect of the family *Ascalaphidæ*, from Swan River, presenting the peculiarity of having a large bifid hump on the basal segment of the abdomen, dorsally, each division of the hump bearing a crest of hairs. He believed it to be the male of *Suphalasca magna*, M'Lachlan.—Mr. Wormald exhibited a collection of Coleoptera, Neuroptera, and Lepidoptera, sent by Mr. H. Pryer, from Yokohama.—Prof. Westwood communicated descriptions of some new species of short-tongued bees belonging to the genus *Nomia*, Latreille; and also a paper, on the species of *Rutelidæ* inhabiting Eastern Asia and the islands of the Eastern Archipelago.—Mr. C. O. Waterhouse communicated a description of a new species belonging to the *Lucanidæ* (*Prosopocœlus Wimberleyi*), by Major F. J. Sidney Parry; and also a description of the male of *Alcimus dilatatus*, by himself.

Royal Microscopical Society, May 5.—Mr. H. C. Sorby, F.R.S., president, in the chair.—A discussion took place upon a paper read at the last meeting by the president, upon spectrum analysis by means of the microscope, and some additional particulars of interest were furnished by the author in reply to questions addressed to him by Dr. Pigott, Dr. Matthews, Mr. Slack, and Mr. Crisp.—Mr. Slack read a paper on the relation of angular aperture to surface markings and accurate vision, in which he showed the fallacy of the present system of using high-angled objectives for these purposes to the exclusion of those of small angular aperture, and pointed out that extreme angles were only to be obtained at the expense of accurate correction and penetrating power.

CAMBRIDGE

Philosophical Society, May 3.—A communication was made by Mr. Pirie, on a method of introducing a current into a galvanometer circuit. Mr. Pirie said that electricians had often to work with currents far too strong for their galvanometer. He mentioned various methods in use for checking the swing of the needle; but contended that an easily made and easily used controller for rough work was a desideratum. He described an instrument in the form of a continuously varying shunt, in which a moving connection was obtained by a tube filled with mercury sliding on a wire of suitable resistance. This form of connection was first used by Prof. Barrett of Dublin. With the aid of Mr. Garnett, the Demonstrator of Physics, Mr. Pirie showed that a very good connection was obtained by this means; and subsequently, that the instrument described gave a control over the movements of the needle in a galvanometer whose resistance was not too different from its own.

GLASGOW

Geological Society, April 15.—Mr. James Thomson, F.G.S., vice-president, read a paper on the geology of the River Liddel, Dumfriesshire. He described several fine sections exposed along the banks of that river, showing wonderful contortions, with great "faults" and "down-throws" of strata. He also referred to the striking identity of the fossils found in a band of impure limestone in that district with those found in many parts of the Ayrshire and Lancashire coal-fields.—Mr. Thomson also read some notes on new species of carboniferous corals, giving an account of his recent investigations in that department.

BERLIN

German Chemical Society, May 10.—T. Böhm studied the influence of various salts on the growth of *Phaseolus multiflorus*, and found lime salts alone efficient for the culture of these plants.—G. Gerlich, bringing into contact sulphocyanide of potassium or of ammonium with bromide of allyl, obtained sulphocyanide of allyl when the reaction was allowed to take place at 0°, while at higher temperatures the isomeric mustard-oil prevailed.—L. Nilson has studied the selenites of beryllium, lanthanium, cerium, didymium, yttrian, erbium, and yttrium. The former metal appeared to enter into the salt as a diad, the rest as triads; thorium as a tetrad.—V. Hæmilian has proved the presence of a considerable portion of ordinary alcohol in commercial methylic alcohol.—L. Pfaundler stated the influence various solvents have on the proportion in which a base is divided between two acids.—W. Ebstein and J. Müller have isolated the ferment contained in the liver and found its action on glycogen to disappear not only when phenol but when the trace of any acid was added.—O. Fischer has transformed methyl-anthracen into methylalizarine, $C_{15}H_{10}O_4$.—A. Ladenburg observed the action of acetic acid on diamines to consist in the formation of ethenyl compounds:

$$\underset{\text{Toluylendiamine.}}{C_7H_6(NH_2)_2} + C_2H_4O_2 = \underset{\text{Ethenyltoluylendiamine.}}{C_7H_6N_2HC_2H_3} + 2H_2O.$$

—V. Meyer and W. Michler, by treating disulphobenzolic acid with cyanide of potassium and potash, have obtained both terepthalic and isophthalic acid in the same reaction.—Drs. von Mering and Musculus, after giving large quantities of chloral to patients, have found an acid in the urine of the composition $C_7H_{12}Cl_2O_6$. They deny the decomposition of chloral into formic acid and chloroform to take place in the human system.—P. T. Austin, treating chloronitrobenzol $C_6H_3(NO_2)_2Cl$ with ethylate of sodium, has obtained the ether $C_6H_3(NO_2)_2OC_2H_4$.—A. W. Hofmann has observed the following reaction of cyanogen on mercaptans $RSH + CN_2 = CNH + R - S - C = N$. Where R is $= C_3H_5$ allyl, the sulpho-cyanide is first obtained, which at ordinary temperatures passes into the isomerical oil of mustard.—R. Lussy has been able to combine one molecule of toluylenediamine with two molecules of phenyl-iso-sulphocyanate. The compound diphenyl-toluylen-sulphurea, when treated with hydrochloric acid, yields aniline and the mustard-oil of toluylene $C_7H_6''(NCS)_2$.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—A Sketch of Philosophy: J. G. Macvicar, LL.D., D.D. (Wm. Blackwood and Sons).—Wanderings in the Interior of New Guinea: Capt. J. A. Lawson (Chapman and Hall).—The Chemistry of Light and Photography in its applications to Art, Science, and Industry: Dr. Hermann Vogel (H. S. King and Co.)—Fourth (December 1872 to December 1873) and Fifth (December 1873 to December 1874) Annual Reports of the Wellington College Natural Science Society.—Vestiges of the Molten Globe: William Lowthian Green (E. Stanford).—The Native Races of the Pacific States. Vol. ii.: Hubert Howe Bancroft (Longmans).—The Province of Psychology—the Inaugural Address at the First Meeting, April 14, 1875, of the Psychological Society of Great Britain, by the President, Mr. Serjeant Cox.—On the Distribution of Rain over the British Isles during the Year 1874. Compiled by G. J. Symons, F.R.B.S. (E. Stanford).

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THURSDAY, MAY 27, 1875

THE ARCTIC EXPEDITION

ACCORDING to present arrangements, the Arctic Expedition leaves our shores on Saturday next. We feel that this event is one of no ordinary scientific importance, and indeed that it is significant, in a high degree, of a change which has come over the ideas of the governors and the governed alike in this country.

While prior Expeditions have advanced knowledge on their way to a high northern latitude, the present one sails to a high northern latitude for the purpose of advancing knowledge. We believe that the Admiralty authorities are fully aware of the importance of this distinction, and that when the final Instructions about to be issued to Capt. Nares are published, it will be seen that although they have been compelled to lay down a route and to state a goal to be reached if possible, the advancement of natural knowledge as opposed to mere topography is recognised as the main object.

All the best hearts in Britain will beat higher at the thought of this noble British attempt to drive still further back the boundaries of the unknown and the unexplored in spite of the obvious perils with which the attempt is surrounded. The work is undoubtedly one of difficulty, and although a combination of past experience and present discipline may be regarded as certain to restore to us at some future day the gallant men now aboard the *Alert* and *Discovery*, it is almost too much to hope that both the ships will run the gauntlet of the ice-barriers both out and home. Capt. Nares, we presume, has, as the Admiralty Arctic Committee recommended, full authority to abandon the *Alert* in 1877 if the exploration in 1876 has been final or her escape be doubtful, and the possible abandonment of both ships is contemplated in the Committee's Report: this shows that the Admiralty has counted the cost, and the fact that the Expedition sails shows us how the benefit resulting from scientific inquiry is acknowledged by the Government.

Were the officers of the ships less devoted to the scientific side of their work, or less capable of undertaking it than they are, they might be fairly alarmed at the parting gifts of the men of science which they have received this week in the shape of Instruments of all kinds, a special Arctic Manual of Scientific Inquiry of some eight hundred pages, and Scientific Instructions in the branches of work to which the Council of the Royal Society attaches the highest importance. The Manual, which has been edited by Prof. Rupert Jones on the biological, and by Prof. W. G. Adams on the physical, side, is supposed to contain the most important information already acquired on the various inquiries to be prosecuted; the Instructions being intended to show in what direction and in what manner this information can be extended.

A glance at the Manual and Instructions, to which we shall take occasion to refer more at length on a subsequent occasion, will make many regret that they are not among those who, if they are incurring risk and undergoing privations, will, during the greater part of their absence, be living in a new world of surpassing interest from a scientific point of view, as well as of soul-stirring grandeur, not unmixed with awful beauty; a world in which there is almost a new astronomy, where even the colours of the sky are different, and where not only the physicist but the biologist finds fresh wonders at every step.

The Hydrographer of the Admiralty, Capt. Evans, has made a noble contribution to the volume of Instructions, in the shape of three provisional maps of the Magnetic Elements, not only over the whole of the region to be explored, but including Greenland and part of the region to the west of Baffin's Bay and Davis' Strait. The various inquiries to be prosecuted by the officers and the naturalists of the Expedition, Capt. Feilden and Mr. Hart, are dealt with in the Instructions, among others, by Profs. Stokes, Sir Wm. Thomson, Adams, and Tyndall, the Hydrographer, Mr. Hind, Mr. Spottiswoode, Dr. Haughton, Mr. Scott, Dr. Rae, and Mr. Lockyer, on the physical side; and by Dr. Hooker, Profs. Huxley, Allman, Flower, Maskelyne, Ramsay, and Roscoe, Dr. Günther, Mr. Gwyn Jeffreys, Mr. J. Evans, and Mr. Judd on the biological, geological, and mineralogical sides.

Looking at the contents of the Manual, every possible source of information in Arctic Biology, Geology, and Physics would seem to have been ransacked, and the result is a volume which must be of the highest value, not only to those whose only text-book it will be for the next two or three years, but to all who wish for the best information about the region for which the envied explorers sail on Saturday. Among those whose contributions have been printed in the biological department will be found such names as those of Lütken, Mörch, Giesecké, Hooker, Heer, Nordenskjöld, Huxley, E. Forbes, and many others.. All the most notable Arctic explorers have been drawn upon, from Sabine and Parry down to Payer and Weyprecht; while contributions will be found from many of the greatest living authorities on such subjects as Meteorology, Physical Properties of Ice, Tides and Currents, Geodesy and Pendulum Experiments, Terrestrial Magnetism, and the Aurora.

It will be sufficiently evident, therefore, that those men of science who were anxious for Arctic exploration, and on whose recommendation the Government have fitted out the Expedition, have done all in their power to make it as complete as possible. The sending of the *Valorous* to Disco with the *Alert* and *Discovery* will not only enable it to start under the best conditions, but will enable a new lustre to be added to the whole attempt, in the shape of biological and temperature observations in the waters passed through on the return journey, waters which up to now have never been explored. For this we have to thank Mr. Gwyn Jeffreys, for unless he had volunteered to superintend these researches, they certainly would never have been made. It is to be hoped that the authorities have not been unmindful of the importance of at least duplicating all observations as soon as they are made and of depositing them in safe places, so that whatever may be the fate of the ships, the loss to science shall be reduced to a minimum.

Capt. Nares and those who accompany him may be assured that though they will be lost to sight for a long time to come, they will be by no means forgotten, all will wish them success, and every hint of news will be eagerly welcomed. May the two crews return "all told."

SACHS'S "TEXT-BOOK OF BOTANY"

Text-book of Botany, Morphological and Physiological. By Julius Sachs, Professor of Botany in the University of Würzburg. Translated and annotated by Alfred W. Bennett, M.A., B.Sc., F.L.S., assisted by W. T. Thiselton Dyer, M.A., B.Sc., F.L.S. (Oxford: at the Clarendon Press, 1875.)

IN 1868 the first edition of Dr. Sachs's "Lehrbuch der Botanik" appeared in Germany; a second edition was soon called for, and it appeared in 1870; the third was published in 1873, and the fourth was issued about the end of 1874. The third edition was translated into French and annotated by M. Ph. van Tieghem, and now we have an English translation of the same edition from the hands of Messrs. Bennett and Dyer.

The want of a good text-book of Botany, one that would give an accurate idea of the present state of botanical science, has long been felt by English students. We therefore heartily welcome the appearance of the English translation of Sachs's "Lehrbuch der Botanik," because we feel certain that it will supply that want so long felt, and be of the greatest value to both teachers and students. Our text-books had mostly fallen behind the time, the older ideas and theories were still retained instead of being swept away to make room for new facts or for the more correct interpretation of long-known but imperfectly understood phenomena. The illustrations of the older works were often defective, frequently absolutely incorrect, and yet they descended from text-book to text-book with unfailing regularity. Terms were multiplied needlessly, without any correct appreciation of the facts to be indicated by them; lectures became a mere illustrated botanical glossary, the biology and physiology of plants were almost entirely neglected, and the science rendered as repulsive as possible. In the work now before us we have a text-book of Botany which the teacher can confidently recommend to the student as being an excellent guide; as giving an extensive and trustworthy account of the present state of botanical science in Europe; and while it indicates the theories and problems at present occupying the attention of botanists, it points him to the subjects which will best repay the original investigator. The illustrations form an important feature in the work, most of them being original, and the result of laborious investigation: if borrowed, it was only when the objects were inacessible, or because it seemed impossible to give a better than the figure already in use. This gives a freshness to the book, which is a charm in a text-book of Botany.

Prof. Sachs's work is devoted exclusively to Morphological and Physiological Botany, and therefore differs in its scope from the text-books to which botanical students in this country are accustomed. The whole work is divided into three books. Books I. and II. treat respectively of General and Special Morphology, Book III. being devoted to Physiology. No exhaustive account of the characters of the natural orders of flowering plants is given, a feature which at once places Sachs's text-book in marked contrast to our English ones. All that is given is an enumeration of the orders and families according to the systems recently proposed by Braun and Hanstein. But the want of characters of orders and families cannot be felt by the English student, as he can consult the admirable translation of Le Maout and Decaisne's "Traité Général de Botanique," and there get all he can possibly want. Indeed, we may look upon Sachs and Le Maout and Decaisne as forming a complete work, the one treating fully of such parts of botany as are omitted or only very imperfectly dwelt upon by the other.

The General Morphology of Plants is treated of by Sachs in the three chapters forming the first book. The first chapter deals entirely with the morphology of the cell, and is a most exhaustive treatise on the subject. In describing the nature of the cell, Sachs says: "By far the largest proportion of cells in the living succulent parts of plants, *e.g.* young roots, leaves, internodes, fruits, are seen to be made up of three concentrically-disposed layers; firstly, an outer skin, firm and elastic, the cell-membrane or cell-wall, consisting of a substance peculiar to itself, which we call cellulose. Close up to the inner side of this entirely closed membrane is a second layer, also entirely closed, the substance of which is soft and inelastic, and always contains albuminous matter; H. von Mohl, who first discovered this substance, gave it the very distinctive appellation of Protoplasm. In the condition of cells now under consideration it forms a sac enclosed by the cell-wall, in which usually also other portions of protoplasm are present in the form of plates and threads. Absent from some of the lowest organisms, but present in all the higher plants without exception, there lies imbedded in the protoplasm a roundish body, the substance of which is very similar to that of the protoplasm—the nucleus. The cavity enclosed by the protoplasm sac is filled with a watery fluid, the cell-sap. And besides this, there are also very commonly found in the interior of the cell granular bodies, which, however, may be passed over for the moment." Following this we have an account of the formation of cells, and then the cell-wall, the protoplasm, nucleus, granular and other substances contained in the protoplasm, cell-sap and crystals are each described in turn. The union of cells to form tissues is next described, and Sachs gives us a three-fold division of tissues into epidermal, fibro-vascular, and fundamental or "ground tissue." The section devoted to Primary Meristem and the apical cell will be read with interest, and the facts there stated will probably be new to most English readers.

The Morphology of the External Conformation of Plants is treated of in the last chapter of the first book. In English text-books much space is devoted to "Organography," the physiological method of study being chiefly adopted. Sachs, however, draws a wide distinction between members and organs, and in the section on Metamorphosis shows that all "organs" may be referred to a few original forms. The original forms or morphological members are only five in number, viz., Thallome, Caulome, Phyllome, Trichome, and Root. These members do not perform any functions, but they are capable of being "adapted" or metamorphosed into "organs" performing many very different functions. Take the adaptations of a Phyllome or leaf-member as an illustration of this. Sachs mentions that "the thick scales of a bulb, the skin-like (not "cuticular," as given in the English translation, p. 129, top line) appendages of many tubers, the parts of the calyx and corolla, the stamens and carpels, many tendrils and prickles, &c., are altogether similar (in mode of development) to the green organs which have been termed simply leaves." So with all the other members; they may be modified to perform the most varied functions.

The second book, treating of Special Morphology and outlines of Classification, will probably be found to be the most generally interesting part of the work. It gives a clear and valuable account of all the "classes" of the vegetable kingdom, which, according to our author, are *thirteen* in number, and are to be further arranged in five groups, viz., Thallophytes, Characeæ, Muscineæ, Vascular Cryptogams, and Phanerogams. Here the industry and care of the author are well shown, as he has collected from all trustworthy sources, descriptions of the structure and life-history of typical forms of plants. This classification is slightly modified in the appendix, which is taken from the fourth edition. The distinction between the Algæ and Fungi, namely, that the Algæ contain chlorophyll, while the Fungi do not, is disregarded, and the Algæ, Fungi, and Characeæ made into four classes, the characters being taken from the modes of sexual reproduction. It seems a pity that the division of the Vascular Cryptogams into classes was not reconsidered, as the discovery of the prothallium of Lycopodium breaks down the division into isoporous and heterosporous groups. We prefer a division of the vascular cryptogams into three classes: Filicinæ, Equisetaceæ, and Lycopodinæ. The Filicinæ include four orders—Filices, Marattiaceæ, Ophioglossaceæ, and Rhizocarpeæ—while the Lycopodinæ include three, viz., Lycopodiæ, Selaginellæ, and Isoeteæ. The chapter on the groups of flowerless plants are of great interest, and will be studied with pleasure by those who have only seen the meagre and often untrustworthy account given in some of our text-books.

Passing to the Phanerogams, Sachs considers the distinguishing characteristic of the group to be the formation of the seed. He contrasts the Cryptogams and Phanerogams, and points out the homologies of the reproductive organs. "This organ (the seed) is developed from the ovule, which, in its essential part, the nucleus, produces the embryo-sac, and in this the endosperm and the embryonic vesicle. The latter is fertilised by the pollen-tube, an outgrowth of the pollen-grain, and, after first growing into a pro-embryo, produces the embryo. The phanerogamic plant, which is differentiated into stem-leaves, roots, and hairs, corresponds to the spore-forming (asexual) generation of vascular cryptogams; the embryo-sac to the Macrospore: the pollen-grain to the Microspore: the endosperm is equivalent to the female prothallium; and the seed unites in itself, at least for a time, the two generations, the Prothallium (endosperm) together with the young plants of the second (sexual) generation (the embryo)." Throughout the whole of the chapters of the second book, the influence of the "Theory of Descent" is very evident. Sachs, however, withdraws, in the fourth edition, the pedigree of the vegetable kingdom, which he sketches in Book III. of the present edition. The Phanerogams are divided into three classes, Gymnosperms, Monocotyledons, and Dicotyledons. Our author adheres mainly to the Gymnospermous theory, and certainly the question whether conifers are gymnospermous or not has yet to be decided, notwithstanding the recent controversy of Eichler and Strasburger.

More than one hundred pages are devoted to the Angiosperms, Monocotyledons, and Dicotyledons. In the remarks on the flowers of Angiosperms, many of our long-cherished ideas, the arrangement of stamens, for example, are rudely disturbed. Monadelphous stamens, as in *Malvaceæ*, are shown to be the result of cohesion of primordial stamens, and subsequent branching. The Polyadelphous stamens of Hypericum are formed by branching of three or five primordial stamens. The use of the English terms "regular" and "symmetrical" as applied to flowers, has been a cause of trouble to the translators, and we cannot but express the hope that both these terms may be quietly dropped into oblivion. On the subject of placentation, the statements of Sachs differ from those usually taught in this country. He shows the relation between the parietal and axile forms, and, making two divisions—viz., the ovules produced by carpels, and the ovules produced on the axis—further subdivides both of these into two:—

1. Marginal. Ovules for reflexed margins of carpels.
2. Superficial. Ovules for whole inner surface of the carpel, except on midrib.
3. Lateral. Ovules produced singly or in numbers from floral axis.
4. Terminal. Apex of axis bearing nucleus of ovule.

The formation of the embryo is very carefully described from Hanstein's researches, and the three layers of tissue in the embryo, Dermatogen, Periblem, and Plerom, carefully figured. The great significance of these layers has probably not yet been fully appreciated, and if it holds that axial structures arise from plerom and lateral appendages from periblem tissues, then a most important guide will be obtained enabling us to determine accurately the morphological value of many disputed structures.

In the classification of inflorescences we have Schimper's term Dichasium substituted for the incorrect "dichotomous cyme" used in English works. This is a marked improvement, as it was always a difficulty to the student to find that, although called dichotomous, it was not so. There is also a great difficulty with the terms helicoid and scorpioid. Sachs uses Schimper's terms bostryx and cicinnus. De Candolle, in 1827, used the term scorpioid to distinguish the characteristic inflorescence of Myosotis, the scorpion grass. The recent researches of Kaufmann, Warming, and Kraus, show that the inflorescences of Borragineæ are sympodial arrangements of dichotomies; and we do not think there would be any difficulty in retaining the term scorpioid for them. Bostryx and cicinnus were used by Schimper in 1835, while it was not till 1837 that the brothers Bravais amended De Candolle's definition of scorpioid and introduced the term helicoid. Schimper's terms, therefore, have the priority, and ought to be used. (See Hofmeister's "Handbuch der Phys. Botanik," vol. i. p. 434).

The floral diagrams given by Sachs will be found very useful, and we also think that the adoption of the floral formulæ will be a great assistance to the student. Sachs uses the collective terms for the whorls throughout in his floral formulæ—calyx, corolla, androecium, and gynoecium, while the translators have substituted the name of the individual member of each whorl, sepal, petal, stamen, carpel. This, we venture to think, is a mistake. We have now used for some time the contractions Ca. Co. An. Gn., which we prefer, the only objection being that this formula contains eight letters instead of five.

Many and great difficulties must have been encountered in translating the second book, and these difficulties seem to have been successfully overcome. We have no doubt that further experience will suggest changes and improvements even in the admirable book now before us.

The third book treats of Physiological Botany, and is divided into seven chapters. The first chapter is devoted to the molecular forces in the plant, and the second to the chemical processes in the plant. Naegeli's theory that organised bodies consist of isolated particles or molecules between which water penetrates is here fully described, and the value of the theory in explaining nutrition and growth by intussusception pointed out. The movements of water and gases in plants are also treated of in this chapter. The second chapter deals with the elementary constituents of the food of plants, assimilation and metastasis, and respiration in plants. Sachs describes the separation of oxygen and fixation of carbon as assimilation, and limits the application of the term respiration to the taking up of oxygen and liberation of carbon dioxide. The influence of external conditions, as temperature, light, electricity, and gravitation in plants, forms the subject of the third chapter. The mechanical laws of growth, including the movements of growing parts, are fully described in chapter iv. This chapter will be read with much interest, and many of the statements will be found to be new to English students. The fifth chapter gives a careful *résumé* of what is known regarding the movements met with in full-grown parts of plants, whether periodic or dependent on the action of stimuli. Chapter vi. is devoted to the phenomena of sexual reproduction, the sections on the influence of relationship on sexual cells, and on hybridisation being of much importance. The last chapter is devoted to the origin of species, to varieties, and to the Theory of Descent.

In closing the book after giving the above brief sketch of its contents, we cannot but express our satisfaction at the manner in which Messrs. Bennett and Dyer have done their work. The notes appended to the English edition are of much value, and will assist the student in his studies. We have but one objection to the work, and that is its high price as compared with the German edition. Surely the price will be an obstacle in the way of its extensive circulation. Could anything be done to obviate this? Sachs himself has already issued the physiological portion of the third German edition separately. Why not permit students to obtain one or other of the three books separately? Or might not an abridgment be made, somewhat on the principle of Prantl's Lehrbuch? As a text-book it must exercise a most powerful influence on botanical teaching in this country, and while it will supersede all other text-books for advanced students, we fear that its size and price may prevent it being so widely used as it ought to be. With Sachs' text-book within reach, teachers and students will be themselves to blame if they are behind the time in botanical science. Then, the English edition being translated from the third German edition, students can readily keep up their knowledge, because the "Botanischer Jahresbericht," beginning as it does in 1873, will refer them to all the more recent literature. While we have thus expressed our entire satisfaction with the work of the translators and annotators, let us not forget to mention that the way in which the work is got up does credit both to the Clarendon Press and Messrs. Macmillan and Co.

W. R. M'NAB

DR. CHAMBERS'S "MANUAL OF DIET"

A Manual of Diet in Health and Disease. By T. King Chambers, M.D. (Smith, Elder, and Co., 1875.)

THERE are many writers who, immediately they place pen to paper, seem to be affected with a certain formality of diction and severity of style which prevents them doing justice to their subject in the eyes of the more easily satisfied public, who, while desiring instruction, prefer it to be mixed with a certain amount of that form of interest which can be given it by an apparent "at homeness" on the part of the author. Dr. Chambers does not suffer from this fault. In the work before us he has produced one of the most readable as well as practical manuals on diet which we could want to see. The interest is maintained from beginning to end, and much valuable information is given on many of the important topics of everyday life without the uncomfortable sensation of any effort being needed to obtain it.

The subject is treated of under three headings: General Dietetics, Special Dietetics of Health, and Dietetics in Sickness. The author commences with the question—What is the natural food of man Flesh-eating animals have teeth, jaws, and limbs suitable for capture and tearing, vegetable feeders have bulky viscera, and so on. Applying similar arguments to the human race, "to judge by form and structure alone, the natural food of an adult man must be pronounced to be *nothing*;" from which we must necessarily deduce, as is indicated by other considerations, that man as man assumed his special characters *after* he commenced the employment of instruments for offence and defence. In fact, the developed heel, with which is correlated the non-arboreal habit, is incompatible with the naturally defenceless condition of our species.

The space which is gained by the omission of the chapters on the chemistry, botany, &c., of food stuffs to be found in most works on diet and food, is, as we are told in the preface, employed in a full discussion of many matters connecting food and drink with the daily current of social life. The number of observations which will come home vividly to almost anyone turning over the pages of this work is so numerous that we think a few quotations will give the best idea of their scope. For instance, salads form an important article of diet in every family. "The salad ought to be dressed by one of the daughters of the house, after she has herself dressed for dinner, singing, if not with voice, with her clean, cool fingers, sharp silver knife, and wooden spoon—

> "Weaving spiders, come not here;
> Hence, you long-legged spinners, hence:
> Beetles black, approach not near;
> Worm nor snail, do no offence."

Since the introduction of railways the difficulty in procuring good mutton is acutely felt in all but large cities, and the author makes a suggestion which, where carried out, would much reduce the inconvenience. He recommends those who can do so "to join a 'mutton club,' buying the lambs of a full-sized breed, and keeping them to at least three-and-a-half years old before killing. The price per pound will not be less than charged by the butcher, but it will supply an article twice as good as his." The remarks with reference to eggs are also very much to the point. "High game has fortunately gone out of fashion, and the most frequent form in which we now meet with decomposing albuminoid matter is that of a fusty egg. Some housekeepers seem to consider this quite good enough for made dishes, and thus spoil material worth ten times what they save by their nasty economy. No egg should be allowed to enter the kitchen that has the slightest smell of rotten straw."

In accordance with the opinion of most of the medical profession and of a large body of the public, we read that "as a regular beverage for a healthy person there is no wine in the English market equal to claret." No doubt the statistics of a few years hence will prove that the present reaction against port and sherry will make itself evident in the considerable diminution of the number of those who are liable to be attacked with the gout, and so demonstrate the advantages of the lighter wine.

In the section on the special dietetics of health many important remarks are to be found. Hints are given to those who pursue the commercial, the literary, and professional life, special chapters being devoted to each. The regimen of infancy and motherhood, of childhood and youth, are not omitted. Dr. Chambers is not the only author who inveighs against afternoon tea, and we cannot agree with the argument on which his objections are based. He tells us that "the dilution and washing away of the gastric secretion weakens its power of digesting the subsequent dinner, improperly blunts the appetite, and not unfrequently generates flatulence and dyspepsia." But the gastric juice is not secreted if solid food is not taken, and any fluid introduced into the stomach can hardly but be absorbed within a quarter of an hour or so. The substitute suggested, "a biscuit, and an orange or an ice," is, in our estimation, much more injurious.

Over thirty pages are devoted to the question of the value of alcohol, the results being too lengthy to summarise on the present occasion. They are well worth reviewing. "Some well-meaning persons think to discourage intemperance in drink by affecting a cynical carelessness as to the quality of that which is consumed. . . . However little a man's purse allows him to drink, let it be good."

The question of the dietetics of disease will appeal to all who have the charge or any interest in those who are invalided. They bear the same practical impress as the other portions of the work. Though some of the author's suggestions may appear to be founded on a somewhat dogmatic basis, they all have an element of truth in them which may lead the reader to think twice of the reasons why he is accustomed to adopt any line of action which may be directly opposed to them.

OUR BOOK SHELF

An Elementary Exposition of the Doctrine of Energy. By D. D. Heath, M. A., formerly Fellow of Trinity College, Cambridge. (Longmans, Green, and Co.)

In this book we have a very good elementary exposition of the Doctrine of Energy; perhaps, however, better adapted for the use of schools than for the general public. Indeed, we are told in the preface that the work was developed from a set of lectures given to the senior classes of Surrey County School. In his discussion of fundamental units the author makes some very good and original remarks. He tells us, for instance, in connection with the first law of motion, that "the *rate* and the *direction* of motion with and in which (respectively) a body is moving at any moment is to be considered as part of its *actual condition* at that moment, which it will retain until some adequate cause changes either the velocity or the direction, or both. We may reasonably inquire *how it got* the motion it has, as we may how it came by its shape or its temperature; and again, under what circumstances it will change any of these properties; but not *why*, having got them, it keeps them."

After dismissing the subject of fundamental units, the writer goes on to dynamical energy, a subject which is fully and fairly discussed. The author next proceeds to thermal and other energies, and ends by a brief account of molecular theories. If we have any fault to find, it is that undue preference seems to be given to the British system of units, while the decimal system is overlooked.

We think, too, that in the introductory part of the work the author is not very clear in his statement with regard to energy, where he tells us we may define it to be "the capacity or power of any body or system of bodies, when in a given condition, to do a certain measurable quantity of work; that is, to change its own condition and that of other bodies, exhausting its power by the using of it." We think that the second part of this definition might have been omitted with advantage.

The author, as he tells us in his preface, has endeavoured to give the young student some conception of the *possibility* of explaining the conservation of energy by the theory that all phenomenal changes are really in themselves changes of motion and position among the molecules or ultimate atoms of substances; and he adds the hope that he has succeeded in presenting this as exhibiting a probable surmise, which may be false without vitiating the doctrine previously developed.

This strikes us as being very well put. The conservation of energy would hold if we imagine the universe to be composed of ultimate atoms with forces acting in lines between them; but should it be found that this last conception is inapplicable to portions of the universe, as, for instance, the medium which conveys light, nevertheless it does not follow that the conservation of energy does not still hold true.

The Commercial Handbook of Chemical Analysis. By A. Normandy. New edition, enlarged, by Henry M. Noad, Ph.D., F.R.S. (London: Lockwood and Co., 1875.)

When the late Dr. Normandy first published his work on Commercial Analysis the Adulteration Act did not exist, and the book was chiefly used by chemical manufacturers and by the small class of practical analysts. Dr. Noad's enlarged edition of the work appears very opportunely, and it will be found to be essential to the analysts appointed under the new Act. It contains, in alphabetical order, a concise list of all ordinary substances which can require to be analysed in connection with food and drink, and in addition the methods of analysing many substances which can only be required in special manufactures, or are only used as drugs. Each article commences with an account of the substance in its pure state: this is followed by a list of the most common impurities or adulterations, and then by the best means of detecting them. The adulterations of some common commodities are somewhat startling; thus, bread may contain rye and barley flour, oatmeal, pea and bean meal, potato starch and rice flour, while of mineral constituents there may be lime, alum, magnesia, ground soapstone, and sulphate of copper. The substances sometimes employed to colour sweetmeats, liqueurs, jellies, &c., include some of the most fatal poisons, such as the acetate, arsenite, and carbonate of copper, chromate and iodide of lead, and the sulphides of arsenic and mercury. Indeed, we well remember going over a sweetmeat manufactory, and on remarking on the bright yellow colour of some large comfits we were told that chrome yellow was employed to produce it, our informant evidently having no idea that the substance is a most virulent poison. A long article is devoted to the adulteration and fabrication of wines, and the "plastering" and "fortifying" of sherries is discussed at length. In all cases the most recent results are given, and the work is well edited and carefully written. A glossary at the end of the book will be found useful both to the analyst and the student.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

"The Unseen Universe"

WE have read with satisfaction (NATURE, vol. xii. p. 41), your very candid and fair *précis* of our recent work, "The Unseen Universe." There are, however, one or two comments added in which the writer seems to have misapprehended our meaning, possibly from the fact that in the first edition of such a work the arrangement may be regarded as not having quite taken its final shape.

To begin, we fail to understand what the reviewer means when he says, "It is a mere theological dogma to say that what energy perishes in the visible passes into the invisible universe; and the dogma is worthless as a physical principle on which to build any physical reasoning."

Our views will be found on p. 159 of our book: "*May we not say that when energy is carried from matter into ether it is carried from the visible into the invisible?*" Surely the ether may be looked upon as forming part of the invisible universe, and also as having received a large portion of the energy which was once attached to visible matter.

Our object was to show that we introduced no new dogma inconsistent with the received ideas regarding energy, inasmuch as these contemplate an invisible universe as truly as we ourselves do.

The second point upon which we would remark is the assertion of the reviewer that by regarding the visible universe as an infinite whole, the arguments on which its end and its beginning are inferred seem to vanish. In reply to this we would remark, that even allowing (which we are not disposed to allow) that the visible universe is infinite, this would not affect our argument against its past eternity. Our argument (see p. 127 of the book) is, that *the dissipation of the energy of the visible universe proceeds*, pari passu, *with the aggregation of mass, and the very fact therefore that the large masses of the universe are of finite size is sufficient to assure us that the process cannot have been going on for ever.*

THE AUTHORS OF "THE UNSEEN UNIVERSE."

Sense of Humour and Reason in Animals

IN the recently published edition of the "Descent of Man" there is some additional matter concerning the above subjects, and as the following illustrative cases fell under my own observation, I think it is worth while to publish them as supplementary to those adduced by Mr. Darwin.

Several years ago I used to watch carefully the young Orang Outang at the Zoological Gardens, and I am quite sure that she manifested a sense of the ludicrous. One example will suffice. Her feeding-tin was of a somewhat peculiar shape, and when it was empty she used sometimes to invert it upon her head. The tin then presented a comical resemblance to a bonnet, and as its wearer would generally favour the spectators with a broad grin at the time of putting it on, she never failed to raise a laugh from them. Her success in this respect was evidently attended with no small gratification on her part.

I once had a Skye terrier which, like all of his kind, was very intelligent. When in good humour he had several tricks, which I know to have been self-taught, and the sole object of which was evidently to excite laughter. For instance, while lying upon one side and violently grinning,[*] he would hold one leg in his mouth. Under such circumstances nothing pleased him so much as having his joke duly appreciated, while if no notice was taken of him he would become sulky. On the other hand, nothing that could happen displeased him so much as being laughed at when he did not intend to be ridiculous. Mr. Darwin says:—"Several observers have stated that monkeys certainly dislike being laughed at" (p. 71). There can be little or no doubt that this is true of monkeys; but I never knew of a really good case among dogs save this one, and here the signs of dislike were unequivocal. To give one instance. He used to be very fond of catching flies upon the window-panes, and if ridiculed when unsuccessful, was evidently much annoyed. On one occasion, in order to see what he would do, I purposely laughed immoderately every time he failed. It so happened that he did so several times in succession—partly, I believe, in consequence of my laughing—and eventually he became so distressed that he positively *pretended* to catch the fly, going through all the appropriate actions with his lips and tongue, and afterwards rubbing the ground with his neck as if to kill the victim: he then looked up at me with a triumphant air of success. So well was the whole process simulated, that I should have been quite deceived, had I not seen that the fly was still upon the window. Accordingly I drew his attention to this fact, as well as to the absence of anything upon the floor; and when he saw that his hypocrisy had been detected, he slunk away under some furniture, evidently very much ashamed of himself.

The following example of *reason* in a dog is the most striking that has ever fallen within my personal observation. A son of the above-mentioned terrier followed a conveyance from the house at which I resided in the country, to a town ten miles distant. *He only did this on one occasion*, and about five months afterwards was taken by *train* to the same town as a present to some friends there. Shortly afterwards I called upon these friends in a different conveyance from the one which the dog had previously followed; but the latter may have known that the two conveyances belonged to the same house. Anyhow, after I had put up the horses at an inn, I spent the morning with the terrier and his new masters, and in the afternoon was accompanied by them to the inn. I should have mentioned that the inn was the same as that at which the conveyance had been put up on the previous occasion, five months before. Now, the dog evidently remembered this, and, reasoning from analogy, inferred that I was about to return. This is shown by the fact that he stole away from our party—although at what precise moment he did so I cannot say, but it was certainly *after* we had arrived at the inn; for subsequently we all remembered his having entered the coffee-room with us. Now, not only did he infer from a single precedent that I was going home, and make up his mind to go with me; but he also further reasoned thus:—"As my previous master lately sent me to town, it is probable that he does not want me to return with him to the country: therefore, if I am to seize this opportunity of resuming my poaching life, I must now steal a march upon the conveyance. But not only so, my former master may possibly pick me up and return with me to my proper owners: therefore I must take care only to intercept the conveyance at a point sufficiently far without the town, to make sure that he will not think it worth his while to go back with me." Complicated as this train of reasoning is, it is the simplest one I can devise to account for the fact, that slightly beyond the *third* milestone the terrier was awaiting me—lying right in the middle of the road with his face towards the town. I should add that the second two miles of the road were quite straight; so that I could easily have seen the dog if he had been merely running a comparatively short distance in front of the horses. Why this animal should never have returned to his former home on his own account, I cannot suggest; but I think it was merely due to an excessive caution which he also manifested in other things. Be the explanation of this, however, what it may, as a fact he never did venture to come back upon his own account, notwithstanding there never was a subsequent occasion upon which any of his former friends went to the town but the terrier was sure to return with them, having always found some way of escape from his intended imprisonment.

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[*] This habit of violently grinning is not, I believe, uncommon among Skye terriers—the pure original breed of Skyes, I mean, and not the broad-nosed shaggy-coated animals which have almost supplanted them. The habit is very remarkable, for there can be no doubt, I think, that it is intended to imitate laughter. Many intelligent dogs understand the meaning of laughter as implying good humour. I have a setter just now, which always rouses up and whines for admittance to a room when he hears a good laugh going on, wagging his tail the while, in proportion to the varying intensity of the laughter; but I do not know of any other breed of dogs which actually *imitates* it - at all events not with such evident purpose as do Skye terriers. The purpose is evident, not only because the gesture is never made at any other time than when the animal wishes to be particularly agreeable; but also because the grin is carried to a highly unnatural degree—much more, *e.g.*, than the strongest snarl would require; and, which is stranger still, I have frequently seen my terrier on such occasions shaking his sides in a convulsive manner—an action he never performed at any other time.

Regent's Park, N.W. GEORGE J. ROMANES

Equilibrium of Gases

IN a former letter (NATURE, vol. xi. p. 486) I ventured to express an opinion contrary to that of most authorities, that the temperature of a vertical column of gas at rest would tend to diminish from below upwards.

I then stated that there was nothing to counteract the tendency to the upward diminution of energy which must result from gravitation. I am indebted to Mr. S. H. Burbury for pointing out to me that a counter-action exists in the removal from the system, at every point of the ascent, of those molecules whose vertical energy at that point is *nil*. The total mean energy of the molecules may thus remain the same, although a constant deduction is made from the energy of every molecule remaining in the system.

Mr. Murphy's argument (NATURE, vol. xii. p. 26) from the absence of cumulus in the Arctic regions, is also a sound one as far as it goes, and fairly counterbalances that derived from tropical calms and storms.

I must therefore withdraw my dissent from the generally received doctrine of the tendency to equality of temperature in a vertical column. R. C. NICHOLS

Athenæum Club, May 20

Contributions to the Natural History of the Wolf (*Canis pallipes*) of Northern India

HAVING had the opportunity of examining a number of wolf-cubs, it may not be without some interest to record my observations in your useful journal.

This year (1874–75) I examined fourteen batches or litters of wolf-cubs between December 18 and February 1. Judging from the apparent ages of the different litters, I should fix the breeding time of the wolf from about the middle of October to about the end of December. But the majority are bred in December, as out of the fourteen batches I could approximately fix the birth of eleven of them in some date of December. On the 29th of December a full-grown she-wolf, in milk, was brought to me, with seven cubs, which appeared to be about a week old. She had ten teats. The eyes and ears of the cubs were closed; their ears were drooping; their general superficial colour was sooty brown, with an under colour, that is, at the roots of the hairs, of dirty light tan. The latter colour was more marked on the head and flanks, while the sootiness was more decided on the hinder part of the body. They all had a milk-white chest-spot varying in size. Six of them had white hairs at the tips of their tails.

All those I examined, of about this same age, had similar characters. When the eyes of young wolves open, and they begin to crawl, about the third week, their general colour is a dirty light tan, washed with soot. As they grow, their ears become erect, their general colour a uniform light tan, with only the tips of the hairs dark, the tail being the darkest part of the animal. After the sixth week or so, the white chest-spot emerges into the light fawn colour of the remainder of the chest, and a dark collar on the under part of the neck becomes visible. This collar looks as if dark grey ashes were brushed across the greyish white of the neck. All those I examined which looked older than four or five weeks had this collar. But it disappears again as the wolf gains its adult colouring, becoming merged into the uniform creamy white of the neck and chest. Out of seventy-nine wolf-cubs which I examined, all but one had a white chest-spot, varying in size from a few hairs to a patch the size of a rupee. Fourteen of them had white tips to their tails, varying in size. Seventeen of them had white tips to one or more of their feet. These white marks leave no doubt about the close relationship between the wolf and the domestic dog. The sex of seventy-four cubs was noted, belonging to thirteen litters. Forty were males, and thirty-four were females. The number of young at a birth was from three to eight.

Lucknow E. BONAVIA

OUR ASTRONOMICAL COLUMN

I LEPORIS (FL.).—This star is wanting in both Argelander's *Uranometria* and in Heis's Atlas, though the estimations of magnitude are very accordant; indeed, with the exception of Lalande, who calls it 6½ observers including Flamsteed, Bradley, Piazzi, and Johnson appear to have uniformly estimated it . It is 4½′ *s.p.* ε Leporis, a star of the 4th magnitude. Baily has this note: "The star is designated as of the 9th magnitude in the *British Catalogue;* but I apprehend this is a typographical error, as it is stated to be the 6th in the original entry." Yet, the star having been omitted by Argelander, and particularly by Heis, there remains a suspicion of variability of light.

THE COMET OF DECEMBER 1872 (KLINKERFUES—POGSON). The observation of a telescopic comet by Mr. Pogson, at Madras, on the mornings of December 3 and 4, 1872, in consequence of a telegraphic message from Prof. Klinkerfues, of Göttingen, that Biela's Comet had "touched the earth" on November 27, and might be sought for near the star θ Centauri, will be fresh in the recollection of our astronomical readers. The remarkable shower of meteors on that evening had exhibited a radiant almost identical in position, with the diverging point, which meteors moving in the orbit of Biela's Comet would have, and hence the assumption of our close proximity to this body during the meteoric display. Places of the comet detected by Mr. Pogson in the first interval of favourable weather after receiving the telegram were communicated by him in the same month to the Astronomer Royal and Prof. Klinkerfues, but without details of the observations upon which they were founded. With the aid of these positions the question of identity of Pogson's Comet with one of the bodies forming Biela's Comet was examined. There was at the outset this difficulty in the way of entertaining the idea of identity, that if Biela's Comet were actually close to the earth on the evening of November 27, its perihelion passage would have taken place on the 27th of the following month, ten or eleven weeks later than the date indicated by Michez's orbit as perturbed to 1866; nevertheless, since the comet was not detected in 1865-66, in the track it should have followed according to Michez's calculations, though the largest telescopes were employed in a search for it, there remained the possibility of disturbance of the mean motion in 1852, when observations were last obtained, from some unknown cause. Klinkerfues, therefore, assuming the elements of Biela's Comet, examined their relation to Pogson's places, and arrived at the conclusion that the identity of the comet observed at Madras with one of the two Biela comets could hardly be doubted. Subsequently, Prof. Oppölzer, of Vienna, gave attention to the subject: he remarked that with Michez's orbit of Biela, Pogson's observations were not represented upon any supposition as to date of perihelion passage, but with the semi-axis of Biela, and assumed small distances of the comet from the earth at the time of the Madras observations, he deduced several sets of the other elements bearing greater or less similarity to those of Biela, and indicating a very near approach to the earth on November 27th: his conclusion was, that Pogson's Comet stands with high probability in intimate connection with the meteor-shower of that evening; and it is at least possible that the observed object was really one of the heads of Biela.

Since these investigations, the full details of the Madras observations have been published in the *Astronomische Nachrichten*, and Prof. Bruhns, of Leipsic, has submitted them to very complete discussion, the results of which he has just made known. His inferences are generally opposed to those drawn by Klinkerfues and Oppölzer. With one of the systems of elements given by the latter, he calculates the apparent path of the comet from Nov. 30 to Dec. 8, finding, as was to be expected, a good agreement with Pogson's observations, and with the rate of motion in R.A. given by his comparisons on the first morning, that of Dec. 3, but the ephemeris does not agree with the rate of motion on the following morning, which, Pogson's differences are sufficient to prove, had not diminished. And it should here be observed that the differences of R.A. were evidently obtained with considerable precision, as might be looked for from so practised an observer as Mr. Pogson. The orbit here referred to is as follows:—Mean anomaly, Dec. 3·0 Berlin time, − 5° 6′·8; longitude of perihelion, 141° 9′; ascending node, 244° 34′; inclination, 10° 28′; angle of excentricity, 54° 17′, the semi-axis major being that assigned by Michez for Biela's Comet, and corresponding to a mean daily motion of 530″·1. Again, Bruhns observes that it speaks further against the identity, that by all the ephemerides, at least from Nov. 23 to Dec. 3, the first days in the northern and later in the southern hemisphere the comet should have been more conspicuous than at the time of Pogson's observations, and it is unlikely that it would have escaped notice, particularly in the northern hemisphere. He so far agrees with Oppölzer, that no assumed date for perihelion passage will bring about an agreement of places calculated from the elements of Biela, with those observed; and that an extension of the comet's period of revolution to 2528 days, without a near approach to the planet Jupiter, is most improbable. In Oppölzer's orbit given above, the inclination is 10° 28′, while that deduced by Michez is 12° 22′; and to prove that such diminution is not to be accounted for by perturbation during the assumed near approach of Biela to the earth about the time of the meteor-shower, he has calculated the effect of the earth upon the elements of Biela, with the perihelion passage fixed to Dec. 27·75, the epoch which would occasion the nearest approach of the two bodies. The inclination of the orbit to the ecliptic is found to be increased 1′·6 only, the node is advanced 0′·4, the perihelion longitude 7′·3, and the angle of excentricity is diminished 1′·6. The earth's perturbations during such a near approach as is possible in the orbit of Biela (for 1866) would not therefore account for a change of elements sufficient to represent the places of Pogson's Comet. Bruhns then makes two assumptions with regard to the ratio of the curtate distances of the comet from the earth at the times of the Madras observations on Dec. 3 and 4, and in both cases arrives at *retrograde* orbits: the motion of Biela's Comet is *direct*. The first of these orbits from which he computes an ephemeris is as follows (we adapt the longitude of perihelion and the inclination to the catalogue form of expressing them):—Perihelion passage 1872, Dec. 15·3763 Greenwich time; longitude of perihelion, 332° 28′; ascending node, 33° 11′; inclination, 31° 13′; perihelion distance, 0·035205. Hence the track of the comet would be—

	R A.		Decl.		DISTANCE FROM	
12h.	h.	m.	°	′	Sun.	Earth.
Nov. 5	11	10·3	20	13 S.	1·251	1·606
,, 13	11	37·3	23	42	1·073	1·359
,, 21	12	18·1	28	10	0·879	1·118
,, 29	13	27·8	33	14	0 663	0·906
Dec. 3	14	21·5	35	4	0·541	0·828
,, 7	15	30·0	34	50 S.	0·405	0·787

We believe there is little doubt that, so far as can be ascertained from Pogson's two days' positions and the rate of motion indicated by his comparisons, the orbit of the comet observed by him was *retrograde*, and therefore agree with the inference of Prof. Bruhns that it had no relation to Biela's Comet, or, we may add, to the magnificent meteoric display of 1872, Nov. 27, notwithstanding the singularity of its discovery by Pogson, in consequence of the telegram sent to him by Klinkerfues, which was grounded on the opposite opinion.

LECTURES AT THE ZOOLOGICAL GARDENS[*]

IV.

May 13.—Mr. Garrod on Antelopes and their Allies

THE true Ruminant Animals characterised among Artiodactylate Ungulata by the absence of incisor teeth in the upper jaw, as well as by the possession of a stomach in which three separate compartments, named paunch, honeycomb bag, and reed, are always present,[†] naturally fall into three different families, the Chevrotains, the Deer, and the Antelopes. The first and last of these remain for consideration.

In the Antilopine, or Cavicorn section, as the latter name implies, the horns are hollow organs. They are epidermic in structure, being composed of hairs agglutinated together to form tubes, which are moulded and fixed upon osseous protuberances of the frontal bones. These "horn cores" are quite different in their nature from the antlers of the deer tribe, as they persist throughout the life of the individual, and are perfectly continuous in their structure with the bones from which they spring. The horns themselves bear much the same relation to the thin layer of vascular membrane which covers the "cores" that the nails on the fingers do to the subjacent soft parts; in the Rhinoceros the horn or horns, though similar in structure, are solid throughout. In many species the horns are present in both sexes, and in one genus (*Tetraceros*) there are two pairs, one attached near the anterior and the other near the posterior margin of the frontal bones.

Many attempts have been made to classify these animals by means of the peculiar structures which are found in some species and not in others. Among the most important of these are the condition of the muffle, or tip of the nose, which is moist in some, as in the ox, and hairy in others, as the sheep. The gland below the eye is also a varying feature, being largely developed in the Indian Antelope, for example, and absent in the Eland. In most species there are two small "false hoofs," remnants of the second and fifth digits, behind the true foot. These, however, are absent in the Royal Antelope and the Pallah. Whether the horns are cylindrical, as in the Chamois, or grooved, as in the Koodo; straight, as in the Oryx, arched, as in the Ibex, or spiral, as in the Markhour; smooth, as in the ox, or transversely ringed as in most, are also tangible characters, by the combination of which with others of less significance various endeavours have been made to arrange the family. These, nevertheless, are none of them satisfactory, on account of the large number of the possible combinations which are to be actually found, at the same time that the relative importance of the different included characters is scarcely capable of being estimated.

There are two animals, the Giraffe of Africa and the Pronghorn, or Cabrit, of the western regions of North America, which are evidently closely allied to the Antelopes, and are probably nothing more than extreme modifications of them. In both, the horn processes or horns are developed in both sexes, at the same time that neither possess false hoofs. The abnormal feature in the Giraffe is found in the horn-like developments, which are pedestals of bone, covered with the ordinary skin of the body, and capped with a tuft of hair. These pedestals, however, differ very materially from those in the Muntjacs among the Deer, and from the horn-cores of the typical

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[*] Continued from p. 28.

[†] A fourth, the manyplies, is found in all but the Chevrotains.

Cavicornia, in being independent ossifications, situated, on the suture between the frontal and parietal bones instead of simple outgrowths from the frontal only. A median excrescence on the forehead, in front of the above-mentioned processes, is the result of a protrusion upwards of the bones in the part.

The Pronghorn (*Antilocapra*) has well-developed horns. They are attached to ordinary bony cores, exactly similar to those of the Antelopes. They are, however, unique of their kind in that they are branched or bifurcate at their tips, a second smaller point springing from the anterior margin of the flattened stem, and running forward with a gentle curve, convex upwards. In another respect these horns are even more peculiar. Mr. Bartlett, the Superintendent of the Society's Gardens, was the first to show, from a specimen living in the Gardens, that the Pronghorn is in the habit of annually shedding its horns from off their cores. This surprising discovery has since been fully confirmed; at the end of each season the core being found covered with a skin from which the fresh horn is developed.

Respecting the geographical distribution of the Cavicornia, none are to be found in Australasia or in South America. Very few inhabit North America; the Bighorn Sheep, one of the Bisons, the Musk Ox, the Mountain Goat, and the Pronghorn embracing them all. Africa is the head-quarters of the sub-order, and specially of the Antilopine family. In Europe the Bison is a native of Poland, the Chamois and the Ibex of the Alps; whilst the peculiar Saïga reaches our side of the Caspian Sea. Among the best known Indian Antelopes are the Sasin or Antelope *par excellence*, and the Nilghau.

The Chevrotains, or Tragulidæ, form a group of small, deer-like animals, without horns, which were formerly associated with the Musk Deer. The investigations of Prof Flower have, more than any others, proved the independent nature of the group, which approach in their internal anatomy to the Pigs. The third stomach of other Ruminants—the Psalterium—is wanting. In the axis vertebra, the odontoid process, instead of being scooped into a spout, as in the Deer and Antelopes, is peg-like, as in the Swine. The second and fifth metacarpal bones are completely developed from end to end, and the lateral marginal intervals of the upper jaw between the canine and molar teeth are not cut away, as they are in other Ruminants. These and other peculiarities in the teeth, &c., are quite sufficient to divide off the sub-order as an independent one, ranking with the others previously described. The number of genera and species are very inconsiderable, there being two of the former (*Hyomoschus* and *Tragulus*), and not half a dozen of the latter. *Hyomoschus* inhabits Western Africa, occupying much the same ground as does the Chimpanzee. In it the metacarpal bones remain separate during the life of the animal, as in the Swine, and not in the other Ruminants. The fur is spotted like that of most young deer, throughout life. *Tragulus* is found, two species—*T. meminna* and *T. stanleyanus*—in India, the Napu (*T. javanicus*) and one or two others making Java and Sumatra their abode.

(*To be continued.*)

RARE ANIMAL AT THE MANCHESTER AQUARIUM

AMONG the numerous new accessions brought together to swell the list of special attractions for the throngs of Whit-week visitors at the Manchester Aquarium, one of the latest arrivals is especially deserving of notice in these columns. This is an example of the so-called "Congo Snake" (*Murænopsis tridactvla*), from the neighbourhood of New Orleans, a singular eel or snake-like animal, belonging, nevertheless, to neither of the classes represented by those two types, but rather to the true Amphibia. Judging from its shape, proportions, and colour, the uninitiated would certainly pass it as an ordinary eel, from which, on closer examination, it will be found to differ in possessing no fins, small bead-like eyes a mere puncture in the place of the ordinary gill-operculum, though more especially in having stationed at each extremity of the attenuated body a pair of feeble little legs, and each leg furnished with three slender toes. These legs may be described as almost rudimentary, but they are at the same time used by the animal, and with more marked effect than might be presupposed, when crawling over the ground at the bottom of its tank. Rising into the midst of the water, it can further swim with great rapidity, progressing then by rapid undulations of its body from side to side, after the manner of a true snake. The length of this specimen is about two feet six inches; greatest diameter, in the centre of the body, one inch and a half, tapering off from the posterior pair of legs into an attenuate and slightly compressed tail. The colour closely resembles that of an ordinary eel, being slate-grey on the dorsal surface and sides down to the lateral line, and below this, ash colour. Along the lateral line is a double row of minute punctures, the orifices, no doubt, of mucous glands similar to those obtaining in true fishes. The animal has to repair to the surface of the water to breathe, but this is at distant intervals, a large quantity of air being drawn through the nostrils into the lung-pouch by a singular inflation of the throat, repeated several times in succession. This specimen is exhibited in one of the octagon table tanks in the centre of the saloon, eighteen inches in depth, so that when taking in its supply of air it does not altogether leave the ground, but raises itself in a semi-erect position until the head touches the surface of the water. With the head just an inch or two below the surface, and standing, as it were, upon its posterior legs, with the anterior pair held out helplessly in the water, is a very favourite attitude with this creature, though at the same time an essentially grotesque one, reminding the observer of the somewhat similar attitude and general appearance, on a colossal scale, of the larva of *Ourapteryx* or other of the Geometria moths. In its native swamps the "Congo Snake" is reputed by the black population to be highly venomous, an injustice to the poor creature as great as when applied by our own benighted countrymen to the harmless Newt or Triton of English ponds and streams, and of which it is merely a highly interesting and most extraordinary exotic type.

We are indebted for this rare and, indeed, at present, we believe, in this country, unique example of this species to Capt. A. H. Mellon, of the Dominion and Mississippi Steamship Company, to whose influential and friendly assistance we are also under further obligations for a fine young alligator some two feet long, the trophy of a preceding voyage.

W. SAVILLE-KENT

THE PROGRESS OF THE TELEGRAPH *

VI.

IT has already been observed that from the limited speed on the wire, the development of any extended system of telegraphic communication between the centres of commerce in a country where great distances have to be reached, involves a vast outlay in the duplication of the circuits necessary to afford the requisite transmitting powers, and that by the adoption of the automatic process, in addition to the accuracy of its performance, the greater speed obtained upon long circuits enabled the telegraphic service to be conducted by a much smaller number of wires, thus reducing in a most important degree the outlay of capital expended on construction. It is not, however, only by the automatic process that the full transmitting capacity of a conducting wire can be attained. Metallic conductors under certain conditions are capable of transmitting more than one current at the same instant of time, both in the same and in opposite directions; and by a very ingenious system of adjustment of electric resistances and balance of currents, perfected by Messrs. Stearns, Edison, and Prescott, the American electricians, intelligence can be transmitted and recorded over a single wire in opposite directions at the same moment. This system of transmission is known as "Duplex" and "Quadruplex" Telegraphy, and is already extensively employed by the Western Union Telegraph Company in the United States, and over several of the more important circuits in Great Britain. The "Duplex" system is working in America between nearly all the principal cities, and has recently been introduced between Port Hastings, on the island of Cape Breton, where the land circuits are in connection with the submarine cables, and San-Francisco, a distance little short of 5,000 miles. The "Quadruplex" system has been successfully introduced between New York and Boston, with a transmitting capacity upon a single wire equivalent to the transmitting power of four wires worked upon the ordinary Morse system. Thus, by employing arrangements such as the "Duplex" and "Quadruplex," a circuit may be worked either as one wire, or two, three, or four wires, according as the transmitting capacity of the circuit may require to be increased.

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* Continued from p. 32.

As is well known, several sounds may be conveyed at one and the same time by vibrations through a rod without interference, and it is difficult to realise the accuracy with which every vibration is reproduced by anyone who has not witnessed an illustration of the "transmission of sound" by solid conductors. So it is with "Duplex" and "Quadruplex" transmissions through the same wire in opposite directions at the same moment of time; it is equally difficult to realise how distinct signals can be received at either end without interfering with or destroying each other; and yet the principles involved are very simple and easy of explanation.

By the Duplex system, one of the most difficult problems incident to the successful development of telegraphic lines has been solved, namely, how to provide for the annual increase (averaging 20 per cent.) in the amount of business without the annual expenditure on capital account for the erection of additional wires. In the United States, over 150,000 miles of wire are in operation, the rate of increase being something like 20,000 miles per annum, and the Duplex system is capable of doubling the carrying capacity of these wires. The great value of the Duplex system consists in its capability to double the capacity of a wire at any moment, should injury by storm or conflagration interrupt the circuits. By its means, the moment one wire is restored to continuity it becomes equivalent to two, and a second wire raises the carrying capacity of the circuits to four wires, and by skilful manipulation the system may be introduced and adjusted on a circuit in about a minute. From the earliest days of telegraphy it has been well known that two currents, either in the same or in opposite directions, could be passed simultaneously through a conducting wire; indeed, by this means, often has the frame of mind and temper of the operator at the distant station been clearly read at the receiving station, even though situated some hundred miles distant. When the direction of the currents from the two stations are passed into the wire in the same direction, the directive force of the needle becomes more decided, and when the direction is contrary the motion of the needle will be comparatively neutralised and scarcely perceptible. The effect of a current transmitted along a wire from one station upon a galvanometer needle while currents are being transmitted from another station has therefore been long known. How this circumstance has been applied to the indication of distinct signals will now be explained.

Let us suppose two stations, A and B, are to be connected for signalling each other upon the Duplex system: the action of the coils in the instruments at the respective stations is so arranged that neither station's local or outgoing current shall affect its needle when passed into the line, its dial being left free to indicate the effects produced by the incoming current from the distant station. For this purpose it is necessary to wind the coils of the instruments with two parallel wires after the manner of a differential galvanometer. Now, as is well understood in testing a line wire for resistance between two stations with a differential galvanometer, until the artificial resistance interposed has been made equal to that of the line to be tested, the battery current passed by the key into the galvanometer will move the needle in the one direction if the artificial resistance is too small, and in the other direction if the resistance is too great. It is only when an accurate balance is obtained—that is, when the two resistances have been made equal—that a current will not move the needle, because then the current is equally divided between the coil connected with the artificial resistance and that connected to the line, which two coils being wound in opposite directions counteract one another. Thus, so long as the artificial resistances (rheostats) at each end of the line are equal to that of the circuit, each station will see the current sent by the other, while neither station will see upon his own instrument the current he is passing into the line; and for this reason, that the currents sent by each station divide equally between the line and the rheostat, passing through the coils in opposite directions, and have therefore no effect upon the needle of the sending instrument. When the distant station sends a current, it either increases or diminishes the effect of the home current; in the first case, it augments that portion which passes through the coil connected to the line, so that more flows into the line than into the rheostat, and the needle moves. In the second case, it reduces the current flowing to the line, and more will flow through the rheostat, moving the needle in an opposite direction. Thus it is seen that the two currents do not pass one another, but that when both stations signal at the same time, the current sent by either of them acts upon the distant instrument by determining whether the currents sent by that station shall pass through the line or the rheostat. Thus we see that when station A signals separately, the current is equally divided in passing through its instrument coil, and its effect is neutralised upon the needle, but it passes through both coils of the distant instrument in the *same* direction, and therefore produces a signal. If both A and B depress their contact keys at the same moment, the currents from the two batteries are united so far as the line wire is concerned, and this produces an effect upon the differential arrangements at each equivalent to a lessening of the resistance of the line, and therefore more current flows to the line than through the rheostat. It is thus seen that the Duplex system affords a means of increasing the transmitting capacity of a wire; and an invention which practically converts one wire into two, three, or four, as the necessities of business may require, is of great value.

A short historical summary of the introduction and progress of the electric telegraph, from its earliest application in a practical form to the establishment of its present world-wide reputation and utility, will be naturally of interest to the general reader; and the following short sketch may convey in a succinct manner the step by step progress that year by year has registered the index of improvement. It is not intended in any way to make the present sketch personal: some well-known names must of necessity be referred to, and the reader should also be informed that the narrator in this instance has personally been more or less connected with the progress of the telegraph from 1844, the date at which this story commences, to 1875, the period under review. In the year first mentioned Charles Wheatstone, Professor of Natural Philosophy at King's College, London, was at the same time connected with a musical instrument and publishing business in Conduit Street, Regent Street. In that house many of his important improvements and patents in connection with the electric telegraph were carried out, and many of the drawings connected with the filing of the specifications of those patents were, by permission of the directors of the East and West India Dock Company, elaborated by a clerk in the Dividend Office of the Dock House, Billiter Square; resolutions standing in the Minute Book of the Dock Board authorising the devoting of his spare time in the office to Mr. Wheatstone's telegraph drawings, and afterwards a resignation in favour of an appointment in the then projected Electric Telegraph Company.

Prefaced with these preliminary remarks, the more immediate subject matter of the present paper will be commenced. It is a matter of history that the early telegraph patents of Cooke and Wheatstone were disposed of for a sum of 120,000*l.* to a Company called the Electric Telegraph Company, in which the late John Lewis Ricardo, M.P. for Stoke-upon-Trent, was at once the mainspring and vital element. Of this amount Cooke retained 90,000*l.*, and Wheatstone received 30,000*l.* This sum included the transfer to the Company, besides other matters, of the telegraph line between Paddington and Slough, on the Great Western Railway, already alluded to in the earlier pages of this summary. As already mentioned, this short line was a kind of Madame Tussaud—daily advertisements, and a profusion of visitors entertained, or, as they imagined, duped or bamboozled, at one shilling a head, into the belief that standing before the little instrument in the Paddington station, it would *there* and *then* convey their thoughts, and in intelligible language return a response from a station some twenty miles distant. Inquiries as to the "time of day," "state of weather," or general health of the operator, served to test the accuracy of the new invention. Nevertheless, nine out of every ten persons who were attracted by the printed placards sown broadcast about the station, left the Paddington terminus as little impressed with any belief that what they had seen represented the future germ of a great invention, as if they had viewed the automaton chess player. Necromancy, witchcraft, and delusion seemed to be the parting impression on their minds as they left, in return for their shilling charge. The announcement as issued in 1844, inviting the patronage of the public, is here reprinted; it affords an amusing souvenir of the early history of the telegraph:—

[*Facsimile of Announcement.*]

"Under the Special Patronage
OF ROYALTY.
INSTANTANEOUS COMMUNICATION
between Paddington and Slough, a distance of
nearly twenty miles, by means of the
ELECTRIC TELEGRAPH,
which may be seen in operation Daily, from nine in the
morning till eight in the evening at the
GREAT WESTERN RAILWAY, Paddington Station,
and the TELEGRAPH COTTAGE, close to the Slough Station.
Admission—One Shilling, Children and Schools halfprice.

Since this very interesting Exhibition has been opened to the Public, it has been honoured by the visits of His Royal Highness Prince Albert, the Emperor of Russia, the King, and Prince William of Prussia, the Duke de Montpensier, His Royal Highness the Duke of Cambridge, the Duke of Wellington, Sir Robert Peel, the Foreign Ambassadors, and most of the nobility, &c.

"In no way has the science of Electricity been made so subservient to the uses of man, as in its application to the purposes of Telegraphic Communication, which is now brought to the *height of perfection.* The working of this beautiful apparatus is not in the least degree affected by the weather, intelligence can be sent by *night* equally well as by *day*; distance is no object; by its extraordinary agency communications can be transmitted to a *thousand miles* in the same space of time, and with the same ease and unerring certainty, as a signal can be sent from London to Slough. According to the best authorities, the electric fluid travels at the rate of 280,000 *miles in a second.*

"The Electric Telegraph has been adopted by Her Majesty's Government, and the Patentees have just completed a line of communication between London and Portsmouth, agreeably to directions received a short time ago from

THE RIGHT HONORABLE THE LORDS OF THE ADMIRALTY.

"In the late trial of John Tawell, at Aylesbury, for the murder at Salt Hill, near Slough, the Electric Telegraph is frequently mentioned in the evidence, and referred to by Mr. Baron Parke in his summing up. The *Times* newspaper very justly observes 'that had it not been for the efficient aid of the Electric Telegraph, both at the Paddington and Slough stations, the greatest difficulty, as well as delay, would have been occasioned in the apprehension of the prisoner.' Although the train in which Tawell came to town was within a very short distance of the Paddington Station before any intelligence was given at the Slough Telegraph Office, nevertheless, before the train had actually arrived, not only had a full description of his person and dress been received, but the particular carriage and compartment in which he rode were accurately described, and an officer was in readiness to watch his movements. His subsequent apprehension is so well known, that any further reference to the subject is unnecessary.

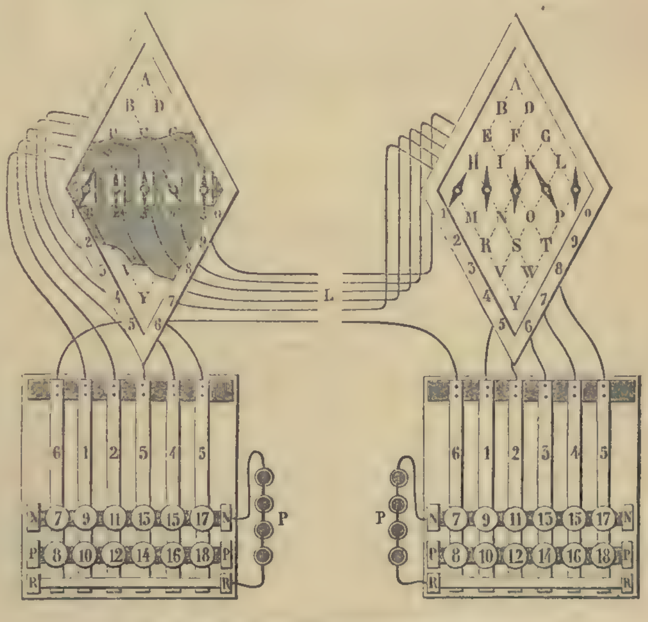

FIG. 26.—Cooke and Wheatstone's five-needle telegraph.]

"The Telegraph Office at Paddington Station is at the end of the Up-train Platform, where a variety of interesting apparatus may be seen in constant operation."

The first office of the Electric Telegraph Company was at 345 Strand, a site now occupied by the Gaiety Theatre. In those days (1846) scientific men of renown crowded the instrument room to witness the progress of this great invention: George Stephenson, the Astronomer Royal, Brunel, Vignoles, G. P. Bidder, Samuda, Rennie, Fairbairn, and most of the leading engineers of the day. In

345, Strand, the magnetic disturbances and interference with transmitted signals from auroræ and earth-currents were first observed and the observations tabulated, which have since proved useful, notwithstanding the then defective construction of the recording apparatus; here also the earliest lines of railway telegraph were inaugurated; the long five-inch astatic combination of the double needle and single needle instruments was employed, taking the place of less perfect apparatus. It must be remembered that, previous to the introduction of the double and single needle instruments, very cumbersome apparatus had been employed. There was the five-needle instrument, requiring five wires for the five needles, and a sixth wire for the return current (Cooke and Wheatstone's patent, 1837); the respective letter or signal being indicated by the concurrent deflection of two pointers. Obviously, this instrument became useless for extended circuits, the capital cost of outlay for the six wires restricting its use. The old letter-showing apparatus of Cooke and Wheatstone (1840), in which the letters of the alphabet composing the word are severally presented to view at an opening in a dial-plate by means of an electro-magnet acting upon the pallets of an escapement, put in motion by independent clockwork. The communicator of the instrument is furnished with a dial-plate similar to that of the indicator, so that on the rotation of the dial of the communicator by the operator, the necessary succession of make and break currents of electricity are sent through the wire and controlled so as to actuate the motion of the index-pointer of the indicator at the distant station.

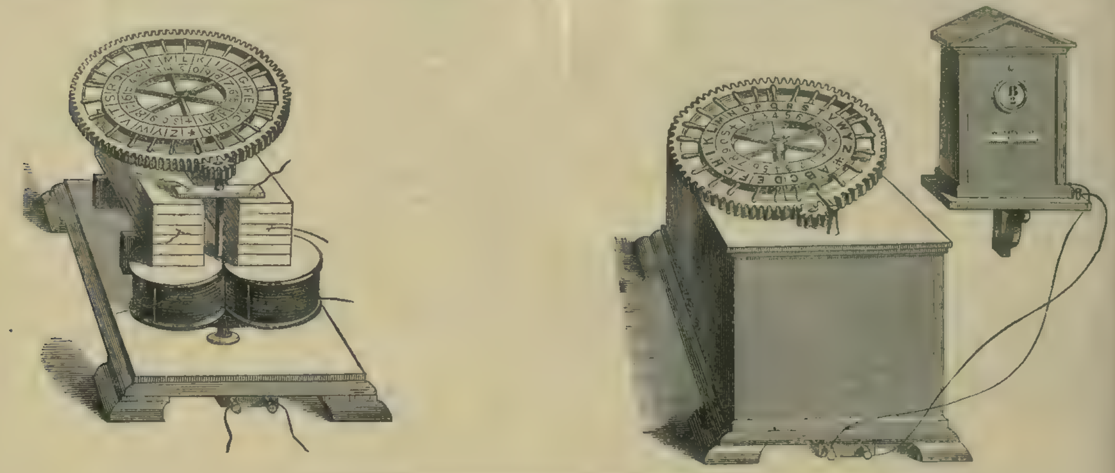

FIG. 27.—Wheatstone's letter-showing dial telegraph, 1840.

(*To be continued.*)

THE INDIAN TRIGONOMETRICAL SURVEY*

ONE does not usually expect to find much of general interest in the Report of a Trigonometrical Survey. Col. Walker's admirably drawn-up Report, however, includes some matter of more than special value; indeed, many of the details connected with the immediate work of the Survey are calculated to interest the general reader, they are concerned to such a large extent with the peculiar difficulties to be overcome by the various parties, difficulties which make ordinary survey work look like mere child's play.

The Index Chart prefixed to the Report enables one to form a very full idea of the work which has already been done, and of how much there is yet to do. From Cape Comorin to Peshawur and all along the Himalayan frontier, and from Kurrachee on the west to Burmah on the east, the country is covered with an intricate net-work of triangulation, including, however, many gaps which will take many years to fill up. Shooting out from the northern border of the system of triangulation are numerous aurora-like lines indicating the secondary triangulation to fix the peaks of the Himalayan and Sooliman ranges. We cannot go into the details of the work of the Survey, and must content ourselves with a brief summary of the out-turn of work during the year under review, and with a reference to a few of the more interesting side topics.

Of Principal Triangulation, with the great theodolites of the Survey, seventy triangles, embracing an area of 7,190 square miles, and disposed in chains which, if united, would extend over a direct distance of 302 miles, and in connection with which three astronomical azimuths of verification have been measured. Of Secondary Triangulation, with vernier theodolites of various sizes, an area of 5,212 square miles has been closely covered with points for the topographical operations, an area of 3,650 square miles has been operated in *pari passu* with the principal triangulation but exterior thereto, and in an area of 12,000 square miles—in the ranges of mountains to the north of the Assam Valley which are inhabited by independent tribes—a large number of peaks have been fixed, many of which have already been found serviceable in the geographical operations now being carried on with the military expedition against the Dufflas. Of Topographical Surveying, an area of 534 square miles has been completed in British portions of the Himalayas, on the scale of one inch to the mile, an area of 2,366 square miles in Kattywar on the two-inch scale, and areas of 690 and 63 square miles respectively, in Guzerat and in the Dehra Dún, on the scale of four inches to the mile. Of Geographical Exploration much valuable work has been done in Kashgharia and on the Pamir Steppes, in connection with Sir Douglas Forsyth's mission to the Court of the Atalik Ghazi, and several additions to the geography of portions of Great Thibet and of Nepaul have been obtained through the agency of native explorers.

In the course of the operations of the year under review the northern section of the Brahmaputra Meridional Series has been completed, whereby two important circuits of triangulation formed by it with the Assam and East Calcutta Longitudinal Series to the north and south, the Calcutta Meridional and the Eastern Frontier Series to the west and east, have been closed. The Straits of the Gulf of Manaar have been reconnoitred, with a view to connecting the triangulation of India with that of Ceylon, which has been found to be feasible.

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* General Report of the Operations of the Great Trigonometrical Survey of India, during 1873–74, by Col. J. T. Walker, R.E., F.R.S., Superintendent of the Survey (Dehra Dun; Office of the Superintendent, G. T. Survey, M. J. O'Connor, 1874.)

Probably the most important features in the operations of the principal triangulation of the year are the resumption of the chain of triangles in Burmah, and the completion of the Bangalore Meridional Series for the revision of the southern section of the Great Arc.

Referring to the revision of certain important triangulations which were originally executed at the commencement of the present century with very inferior instruments, Colonel Walker expresses his conviction that no portion of the principal triangulation remains which will ever require to be revised, and that the last of the old links in all the great chains of triangles which might with any reason have been objected to as weak and faulty, have now been made strong and put on a par with the best modern triangulation.

The pendulum observations have been completed, and the final results are now being computed and prepared for publication.

Considerable assistance was, moreover, rendered to Col. Tennant in the operations connected with the observation of the Transit of Venus; the Appendix contains Mr. Hennessey's account of his observations at Mussooree, the details of which have already appeared in NATURE.

The reports of the various district superintendents are very full, and contain a good deal that is of general interest; the accompanying district sketch-maps are of great use in enabling one to read these reports with understanding. We shall briefly refer to some of the points of more general interest.

In Major Branfill's report on the Bangalore Meridional Series, a very interesting phenomenon is noticed in connection with the Cape Comorin base-line. The operations of 1873–74 were intended to close in a side of the polygon around the base-line which had been completed in 1868-69; but it was found that one of the two stations on the side of junction had disappeared. This station was situated on a remarkable group of Red Sand Hills, where, in 1808, Col. Lambton had constructed a station by driving long pickets into the drift sand; in 1869 Major Branfill, finding no trace of these pickets, had caused a masonry well to be sunk to a depth of ten feet, where it reached what was believed to be firm soil below; but during the interval of four years this well had been undermined, and nothing remained thereof but some scattered *débris*. It would appear that the sand hills travel progressively in the direction from west-north-west to east-south-east, which is that of the prevailing winds in this locality; if Col. Lambton's station was situated on the highest point of the hills and in a similar position relatively to the general mass as Major Branfill's, then the hills must have travelled a distance of about 1,060 yards to the E.S.E., for the results of the triangulation show that this is the distance between the positions of the two stations; thus the rate of progression would be about seventeen yards per annum. From Major Branfill's Notes on the Tinnevelly district, which are appended to the General Report for 1868-69, it appears that certain measurements of the eastward drift had made it as much as 440 yards in the four years 1845-48; but the distance between the trigonometrical stations of 1808 and 1869 probably affords the most accurate measure which has hitherto been obtained of the rate of progress of this remarkable sand-wave, which gradually overwhelms the villages and fields it meets with in its course, and has never yet been effectually arrested; numerous attempts have been made, by growing grass and creepers and planting trees on the sands, to prevent the onward drift, but they have hitherto been unsuccessful.

Mr. Bond, one of Major Branfill's staff, managed to procure an interview with a couple of the wild folk who live in the hill jungles of the western Ghâts, to the south-west of the Palanei hills. A strange dwarfish people had often been heard of as frequenting the jungles near the station of Pémalei, in the north-west corner of the Tinnevelly district, but until Mr. Bond caught these two specimens no trace of them had been seen by the members of the Survey. These two people, a man and a woman, believed themselves to be 100 years old, but Mr. Bond supposes the man to be about twenty-five, and the woman eighteen years of age. "The man," Mr. Bond states, "is 4 feet 6½ inches in height, 26½ inches round the chest, and 18½ inches horizontally round the head over the eyebrows. He has a round head, coarse black, woolly hair, and a dark brown skin. The forehead is low and slightly retreating; the lower part of the face projects like the muzzle of a monkey, and the mouth, which is small and oval, with thick lips, protrudes about an inch beyond his nose; he has short bandy legs, a comparatively long body, and arms that extend almost to his knees: the back just above the buttock is concave, making the stern appear to be much protruded. The hands and fingers are dumpy and always contracted, so that they cannot be made to stretch out quite straight and flat; the palms and fingers are covered with thick skin (more particularly so the tips of the fingers), and the nails are small and imperfect; the feet are broad and thick skinned all over; the hairs of his moustache are of a greyish white, scanty and coarse like bristles, and he has no beard.

"The woman is 4 feet 6½ inches in height, 27 inches round the chest (above the breasts), and 19½ horizontally round the head above the brows; the colour of the skin is sallow, or of a nearly yellow tint; the hair is black, long, and straight, and the features well formed. There is no difference between her appearance and that of the common women of that part of the country. She is pleasant to look at, well developed, and modest." Their only dress is a loose cloth, and they eat flesh, but feed chiefly on roots and honey.

"They have no fixed dwelling places, but sleep on any convenient spot, generally between two rocks or in caves near which they happen to be benighted. They make a fire and cook what they have collected during the day, and keep the fire burning all night for warmth and to keep away wild animals. They worship certain local divinities of the forest—Rákas or Rákári, and Pé (after whom the hill is named, Pé-malei)."

The woman cooks for and waits on the man, eating only after he is satisfied.

The means taken for tidal observations in the Gulf of Kutch promise to lead to valuable results. The object of these observations is to ascertain whether secular changes are taking place in the relative level of the land and sea at the head of the gulf. Very great difficulties were found in selecting suitable stations for fixing the tide-gauges, as the foreshores of the gulf consist mainly of long mud-banks, which often stretch miles into the sea, and are left bare at low water, when they are intersected by innumerable tortuous and shallow creeks, whose shifting channels would be very unfavourable positions for tide-gauges. Only three points suitable for tidal stations were met with on the coasts of the gulf: at Hanstal Point, near the head of the gulf; at Nowanár Point, half-way up, on the Northern or Kutch coast; and at Okha Point, on the southern coast, opposite the island of Beyt. None of these points, however, are situated in ports or harbours, where piers, jetties, landing-stages, or docks might have been utilised; on the contrary, they are all situated at some distance from the nearest inhabited localities, and present no facilities whatever. The operations had thus to be of the very simplest nature. The only practicable plan was to have the tide-gauges set up on shore, over wells sunk near the high-water line, and connected with the sea by piping. The wells are iron cylinders, with an internal diameter of twenty-two inches, which slightly exceeds the diameter of the float; the cylinders were made up in sections of fifty inches in length, the lowest of which is closed below with an iron plate, and the whole, when bolted together, forms a water-tight well, into which water can only enter through the piping for effecting the connection with the sea. The piping is of an internal diameter of two inches, which has been computed to be sufficient to permit of the transmission of the tidal wave to the well without sensible retardation. Iron piping is laid from the well to the line of low water; it is brought vertically up from the bottom of the well nearly to the surface of the ground, and is then carried down to the sea, where flexible gutta-percha piping is attached, and carried into the deep water. The outer piping terminates in a "rose," which is suspended a few feet above the bed of the sea by a buoy, in order to prevent the entrance of silt as much as possible, and it can be readily detached from the iron piping whenever it has to be cleaned.

After many difficulties, and even dangers to life, Capt. Baird's party managed to get the gauges erected and set to work, and what with the tidal observations, observations of the barometric pressure, the velocity and direction of the wind, and the amount of rainfall—for each station has been provided with means for making such observations—very valuable results may be expected.

Lieut. Gibbs's notes on the portion of the Dang Forests, in the Guzerat district, visited by him in 1874, are of great interest, and we regret that space forbids us referring to them in detail. His observations on the inhabitants of this region are of special value; he also seems to have paid considerable attention to the fauna, flora, and geology of the district.

Capt. Heaviside's lively narrative of the pendulum work in India, of his journey home, and of the operations at Kew, will also be read with interest.

Two narratives of somewhat unusual interest are given in the Appendix. One of these, by Lieut.-Col. Montgomerie, gives an account of a journey to the Namcho or Tengri Núr Lake, in Great Thibet, about ninety miles north of the Brahmaputra, by a native explorer, during 1871-72. The explorer was a semi-Thibetan, a young man who had been thoroughly trained for the work, and who was accompanied by four assistants. The party set out from Kumaon in November, and crossed the Brahmaputra at Shigatze, and amid considerable hardships made their way northwards, reaching the lake about the end of January, when they found it completely frozen over, although the water is so salt as to be unfit for drinking. The party intended to travel all round the lake, which is 15,200 feet above the sea, fifty miles long and from sixteen to twenty-five miles broad, and intended to proceed further to the northward and take complete surveys, but were robbed of nearly all they had, and were thus compelled to beat a rapid retreat, which they did by way of Lhásá.

During the great part of his journey to the Namcho Lake the explorer found the streams all hard frozen, and he was consequently much struck by the number of hot springs that he met with, and more especially by the great heat of the water coming from them, his thermometer showing it to vary from 130° to 183° Fahrenheit, being generally over 150°, and often within a few degrees of the boiling point, being in one case 183° when the boiling point was 183¾°. The water generally had a sulphurous smell, and in many cases was ejected with great noise and violence; in one place the force was sufficient to throw the water up from forty to sixty feet. These springs in some respects seem to resemble the geysers of Iceland.

To the south the lake is bounded by a splendid range of snowy peaks, flanked with large glaciers, culminating in the magnificent peak "Jáng Ninjinthanglá," which is probably more than 25,000 feet above the sea. The range was traced for nearly 150 miles, running in a north-easterly direction. To the north of the lake the mountains were not, comparatively speaking, high, nor were there any high peaks visible further north as far as the explorer could see from a commanding point which he climbed up to. He only saw a succession of rounded hills with moderately flat ground in between them. Immediately north he saw a lake of about six miles in length, which he was told was called Bul Cho, from the borax (bul) which is produced there in large quantities, supplying both Lhásá and Shigatze with most of the borax that they require.

The Tengri Núr or "Namcho" Lake is considered to be a sacred place, and although at such a very great distance from habitations and so high above the sea, it boasts of several permanent monasteries and is visited by large numbers of pilgrims. There are several islands in the lake, two of them large enough for monasteries: at the time the explorer was there the Lámas on the islands kept up their communication with the shore by means of the ice, but he did not hear as to what was done in summer. Fish are said to be abundant, and modern lake shells were found on the shore as well as fossil shells, which were very numerous and of all sizes.

The narrative contains many other valuable observations made on the people and the country through which he travelled; there is a good map of the route.

The other narrative is quite equal in interest to that just referred to. It consists of extracts from a native explorer's narrative of his journey from Pítorágarh in Kumaon *viâ* Jumla to Tadum, and then down through Nepaul, along the Gandak River, to British territory. The explorer, who had to exercise much determination and ingenuity, took minute notes by the way of all he saw, and has added much to our knowledge of the geography, the people, and the products of a region comparatively unknown. He had to cross many rivers by the way, which was generally done by means of ropes suspended between the banks. The explorer wished to proceed much further than Tadum, which is a little beyond the Brahmaputra, in Great Thibet, but was prevented by the head man of the village. He started on July 1, 1873, and reached British territory again about the end of November, after having travelled nearly 500 miles. We have space to notice only one interesting phenomenon which he observed. At Muktináth, near Kágbeni, about 11,280 feet above the sea, in N. lat. 29° and E. long. 83° 45′, about 600 feet south of the temple, is a small mound with a little still water at its base, having a sulphurous smell. From a crevice in this mound, at the water's edge, rises a flame about a span above the surface. The people of the place told the explorer that the water sometimes increases in quantity sufficiently to flow into the crevice; the flames then disappear for a while, and there is a gurgling noise, a report, and the flames burst up and show again. This spot is called Chume Giarsa by the Bhots.

Our readers will see, from the cursory glance we have been able to take at this Report, that it contains much valuable matter apart from the immediate work of the Survey, the members of which are doing good service to India and to science.

THE BIOLOGICAL DEPARTMENT OF THE BRITISH MUSEUM

THE newly-issued Report of the condition and development of the British Museum has, so far as biologists are concerned, a special interest. Its results may be considered as an index of the public feeling on the importance of the study of Natural History. Looked at in this light, we think that specialists in all the departments may feel hopeful. The acquisitions to the Zoological Department have been numerous (30,699 in all), over 6,000 being Vertebrata, "the majority being either entir animals preserved in spirits, or skeletons." The spirit collection till recently has been much neglected, and all who have wished to prosecute their investigations into the more intricate details of zoology and comparative anatomy —into points of myology, nerve distribution, &c., quite as important as, but much less easily arrived at than, osteological characters—may justifiably look forward to the time when the national collection will contain, preserved in their entirety, examples of all reasonably-sized species.

"In the acquisition by purchase of skeletons, particular care has been taken [we are told] that they should be those of animals captured in a wild state, the skeletons of mammals (and birds) which have been brought up or have lived for some time in menageries, showing rarely, if ever, a perfect development of the osseous system. Scarcely less caution is required in admitting specimens of this kind into the collection for the sake of their skins." There is a great deal of truth in these remarks, but there are many new species of animals, such as the new Mourning Kangaroo, brought over by M. d'Albertis, and the Hairy-eared Rhinoceros (*Rhinoceros lasiotis*), discovered by Mr. Sclater, and now enjoying perfect health in the Zoological Society's Gardens, which are only known from these individuals.* It would be a loss to the collection if these were not obtained when opportunity afforded, and we are glad to know that the small kangaroo referred to has died and has been secured by Dr. Günther.

We are informed that over three thousand students who have visited the department during the past year, with the object of consulting the various portions of the collections, "have been assisted and attended to." All, we are convinced, will agree in expressing their best thanks to Dr. Albert Günther, who, as the worthy successor of the late Dr. J. E. Gray, has done all in his power to place every facility in the way of those who are desirous of studying Natural History.

NOTES

M. LEVERRIER was expected in England during the present month; but as the revision of his planetary theories, and especially of the Theory of Saturn, in which he has been occupied for some time, is not yet completed, his visit to this country will be delayed.

THE Emperor of Brazil has sent to Prof. Virchow, accompanied by an autograph letter in French, an interesting collection of skulls and skeletons, amongst which are some found in ancient caverns of Brazil. The collection has been made at the Emperor's request by the director of the Museum at Rio, Señor Ladislas Neto. The Emperor regrets that he did not have the pleasure of making Prof. Virchow's acquaintance at Berlin when he visited that city, as the Professor's investigations "are highly esteemed even by those to whom, like myself, it is not given to be more than friends to science."

THE Geographical Society of Rome gave a banquet, on May 11, to the celebrated African traveller Dr. Nachtigal; many of the members and several notabilities of the city of Rome were present in honour of the guest. The Vice-president of the Society, Senator Amari, proposed the health of the guest, who had just returned from a journey through Fezzan, Bornu, Wadai, and Darfur. Dr. Nachtigal, in reply, wished success to the scientific expedition to Central Africa planned by the Society; he considered that this expedition would be an honour to the whole Italian kingdom.

THE transfer of the India Museum to the Eastern Galleries of the International Exhibition Buildings, South Kensington, having been completed, the collection was thrown open to the Institute of Civil Engineers, who had a brilliant *conversazione* in the galleries on Tuesday evening; there were about 2,500 present. Considerable advance has been made in the arrangement of the valuable collections belonging to the Museum, though it must necessarily take some time before everything can find its proper place. There are two galleries, the upper and the lower. In the former, the Manufactures and Arts of India are represented; in the latter, which are not yet finished, the Natural History of Hindostan, the mineral, vegetable, and animal products, are represented. No doubt the India Museum, as it will ultimately be arranged, will become a favourite and instructive resort of the public, and we hope it is only the first step towards the realisation of Dr. Forbes Watson's great scheme of an Indian Institute.

MR. H. H. SCLATER, the naturalist to the Rodrigues section of the late Transit of Venus Expedition, and the Rev. A. E. Eaton, who held the same position at Kerguelen's Land, are both working out the materials which they collected during their stay in the islands which they visited. The former zoologist has obtained a great number of remains of the extinct Solitaire, one skeleton and several skulls being perfect; besides the remains of several other species of birds. Mr. Eaton's specimens include the skeleton of one Cetacean, two Seals, and several species of Petrels.

DR. LYON PLAYFAIR has withdrawn his bill for restricting experiments on animals, on account of the appointment of a Royal Commission on the subject, the names of the members of which have not yet been published.

PROF. LEIDY, the distinguished American biologist, is now in this country.

THE volcanic phenomena in Iceland, of which we have already given some details (vol. xi. p. 514) seem still to be as active as ever, and indeed to be gaining in intensity. Outbreaks have occurred since the beginning of the year to the middle of April, when the latest news left. In March the Dyngjufjöll was incessantly vomiting fire, the eruption was steadily spreading over the wilderness, and the whole region of the My-vatn Mountains was one blazing fire. So large a district of the surrounding country has been covered with ashes that the farmers have been obliged to remove in order to find pasture for their stock. Early in April a new eruption had broken out in a south-easterly direction from Barfell, more than half-way to the east, between it and the Jokulsa. A party went out from Laxárdal to explore, and on approaching the place of eruption they found the fire rising up from three lava craters, in a line from south to north, which it had piled up around itself on a perfectly level piece of ground. At a distance of fifty to eighty fathoms to the west from the craters a large fissure had formed itself as the fire broke out, and the land had sunk in to the depth of about three fathoms. Into the hollow thus formed the lava had poured at first, but now it flowed in a south-westerly direction from the two southern craters. The northernmost crater had the appearance of being oblong, about 300 fathoms in length, and from this crater the molten red-hot lava was thrown about 200 or 300 feet into the air in one compact column. The top of this column then assumed a palmated appearance, and the lava fell down in small particles, like drops from a jet of water, which, as they became separated from the column, grew gradually darker, and split into many pieces, bursting into lesser and lesser fragments as they cooled. No flames were observed, but the glare proceeds from these columns and the seething lava in the craters. At times the explorers could count twenty to thirty of these columns. No real smoke accompanied the eruption, but a bluish steam, which expanded and whitened in colour as it rose to a greater distance from the crater, and such seemed to be the power of this blue jet of steam that it rose straight into the air for many hundreds of fathoms in despite of a heavy wind blowing.

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* A second specimen of the latter species has been just received by Mr. C. Jamrach.

A SHOCK of earthquake was felt at Spezzia, Italy, on May 20. It is possible that the earthquakes which were felt almost daily in Italy a few weeks since were connected with the Icelandic phenomena; generally, any volcanic commotion in Iceland occurs simultaneously with volcanic or seismic phenomena in Italy.

THE University of Cambridge proposes to confer the honorary degree of LL.D. upon Dr. Samuel Birch, F.S.A., the Keeper of Oriental Antiquities in the British Museum.

THE death is announced, on Feb. 5 last, at the age of thirty-five years, in the interior of Africa, of Mr. Frank Oates, F.R.G.S., who, since the beginning of 1873, has been travelling in that country with the twofold object of acquiring an accurate knowledge of its natural features and of studying its fauna. After spending some time in the Matabele country, north of the Limpopo River, towards the end of last year Mr. Oates proceeded to the Victoria Falls, on the Zambesi. Shortly after leaving the Zambesi, when near to the Makalake towns, he succumbed to fever. Mr. Oates's effects, it is hoped, will be brought home by a personal friend, who has recently gone up country from Pietermaritzburg. They include a large number of specimens of natural history and curiosities which Mr. Oates had collected, besides all his notes and papers, and are expected to prove of very considerable interest. Mr. Oates had already made a successful expedition into North and Central America.

THE Report read at the Anniversary of the Royal Geographical Society on Monday shows a net increase of 202 members, the roll of ordinary members now reaching the total of 2,960 The total income of the year was 7,511*l.* 11*s.* 10*d.*, all but about 500*l.* of which has been disbursed. Medals were presented to Count von Beust on behalf of Lieuts. Weyprecht and Payer, and to the successful competitors in the public schools examinations. A presentation gold watch was handed by the chairman, Sir H. C. Rawlinson, to Col. Montgomerie, of the Indian Trigonometrical Survey, for transmission to Mr. W. H. Johnson, the explorer of Kuen Lun and Khotan. The President, in his address, referred to the losses by death sustained by the Society, to the Arctic Expedition, to the Admiralty Surveys in the *Challenger*, the *Basilisk*, the *Shearwater*, and other vessels, and to other geographical topics.

MR. WILLIAM MACLEAY, of Sydney, who has fitted out the expedition for the exploration of New Guinea, is, we believe, an ardent naturalist. The ship he has purchased is named the *Chevert*, and has been placed under the command of Captain Edwards. Mr. Macleay accompanies the expedition, which left Sydney on the 18th inst.

THE body of an American, John Blackford by name, has recently been found in a large ice-block in the vicinity of Mont Blanc, after several days of thaw. The unfortunate tourist had tried three years ago to ascend Mont Blanc without a guide, and had not since been heard of. Features and clothes are perfectly preserved.

IN the vicinity of Salzwedel an immense layer of rock-salt has been discovered. Borings had been made for some time past with a view to discovering coal; the formation of limestone, however, in which these experiments were made, is extremely hard, and the borings made but small progress. At the beginning of this year the first specimens of rock-salt were obtained at a depth of about 730 feet. The borings have now gone 250 feet deeper, and the rock-salt remains the same. It is the intention of the proprietor to go to a depth of 2,000 feet.

MR. MALLET'S paper on "The Nature and Origin of Volcanic Heat and Energy," read to the Royal Society in 1872, and published in Phil. Trans. for 1873, has been translated in full into German by Dr. A. von Lasaulx, Professor of Geology at the University of Bonn, and published as a separate work. We regret that a few clerical errors which escaped correction until the original paper was published, together with the necessary errata, have been overlooked by the translator. The errors are, however, self-evident, and occur in the German translation in paragraphs 186 to 198. The errors originate by dividing, in place of multiplying, a certain number of heat units at line 11, par. 186, and do not affect the argument of the paper.

A LITTLE medal of palladium, with hydrogen occluded in it, now at Leeds, is described by the compiler of the "Yorkshire Exhibition Guide" in the following terms:—"A medal and plate formed of the new metal, palladium, will be interesting to scientific men. The discovery of this metal by Prof. Graham a few years ago finally settled the long-disputed point as to whether or not the gas hydrogen was a metal. He proved that palladium was simply hydrogen condensed. This may be easily exemplified by placing a piece of the metal under the receiver of an air-pump and exhausting the air. The solid metal at once flies off as a gas, and on re-admitting the air it shrinks again into its former size. The little medal shown contains 100 times its volume of the gas." The writer's wild remarks display so much ignorance, that it is to be feared, notwithstanding their calm positiveness, they can hardly be attributed to a firm and cheerful faith in molecular mobility.

THE French Academy of Sciences, at its private meetings, is at present deliberating upon the means of diminishing the expenses of publishing the *Comptes Rendus* without injuring the interest of science. The yearly expense of editing that journal is about 70,000 francs, after deducting the receipts from the sale, which is not very large. The Academy has a very liberal free list, the number of copies presented amounting to many hundreds. It has been proposed by M. Leverrier to use a smaller type. Objections have been raised by some members, who wish merely to diminish the number of pages allotted to the several papers. But it is very likely that the former suggestion will be adopted, and steps taken to make the *Comptes Rendus* less bulky. The *Comptes Rendus* forms yearly two thick quarto volumes. The eightieth volume is in course of publication. The number of pages published since the 1st of June, 1835, is about 100,000.

THE Report of Brigadier-General Myer, Chief Signal Officer of the United States for 1874, has just been received. This Report, giving an admirable *résumé* of the meteorology of the United States for 1873–74, and exhibiting throughout an earnestness and a vigour in the successful application of the science to practical matters, we shall take an early opportunity to bring before our readers.

SYMONS' "British Rainfall," showing the distribution of rain over the British Isles during 1874, as observed at about 1,700 stations, has just been published. It contains, in addition to the usual large mass of valuable information detailing the rainfall of the year, a notice of the remarkable rainfall of October 6, and a map showing its distribution over England and south of Scotland; and papers on the measurement of snow and on the rainfall at certain health-resorts in the United Kingdom. We observe with much satisfaction that the editor has obtained the services of nine gentlemen as county superintendents, to assist him in collecting the rain returns of their respective districts, it being in this way that the observation of this important element will best be rendered still more complete. The publication of the monthly as well as the annual amounts of rain for the whole of the 1,700 stations is very desirable, and it is hoped that in an early issue of the "British Rainfall" it will be done.

A NEW street in Magdeburg has just been called "Guerike Street." Our readers know that Otto von Guerike, some time Burgomaster of Magdeburg, was the inventor of the air-pump.

ON May 20 the Plenipotentiaries of France, Austria, Germany, Italy, Russia, Spain, Portugal, Turkey, Switzerland, Belgium, Sweden, Denmark, the United States, the Argentine Republic, Peru, and Brazil, signed, at Paris, the International Convention for the adoption of the metrical system of weights and measures. A special clause reserves to the States not included in the above list the right of eventually adhering to the Convention.

It was the Hon. T. Elder (not Eden), who, with Mr. Hughes, bore the expenses of Col. Warburton's journey across Australia, the narrative of which we noticed in last week's Nature (p. 46).

The French Association for the Advancement of Science meets at Nantes this year, under the presidency of M. d'Eichtal, an influential banker largely connected with railway interests. The local committee is presided over by the Mayor, and a large sum has been collected for defraying the expenses connected with the meeting.

The annual report of the trustees of the Museum of Comparative Zoology, of Cambridge, U.S., for 1874 has just been published, and contains the current history of that distinguished establishment, as also the list of the additions to its various departments. The strict economy necessary to relieve the Museum from its embarrassments, after the death of Prof. Agassiz, has effected its purpose, and its financial condition is rapidly approaching a satisfactory state.

Prof. Alexander Agassiz announces that the experience of the past two years has shown the impossibility of conducting the Anderson School of Natural History, Penikese Island, upon the plan originally intended. The trustees find themselves at the end of the means at their disposal. To enable them to carry on the school it is proposed to charge a fee of fifty dollars for the season, and they hope that a sufficient number of pupils can be secured to warrant them in going on. Even with the proposed charges there will be a considerable deficit (as was the case last year) to be met by the friends of the Penikese School.

We believe that M. Wallon, the French Minister of Public Instruction, is to present a law for the organisation of the higher education in France.

The *Watford Observer* of May 22 contains reports of two papers read at the last meeting of the Watford Natural History Society: "Introductory Remarks on the Observation of Periodical Natural Phenomena," by Mr. J. Hopkinson, F.L.S., and "Notes on the Observation of Plants," by the Rev. Dr. W. M. Hind. It is gratifying to see local societies turning their attention to subjects of so much importance.

During the first three days of last week the Geologists' Association made an interesting excursion to Charnwood Forest, in Leicestershire. A full report of the proceedings appears in the *Leicester Chronicle* for May 22.

Messrs. Chapman and Hall have just published a translation of F. Jagor's "Travels in the Philippines," of the German edition of which we were able to give a favourable review in vol. viii. p. 138. The translation seems to us to be well done, and the book contains a good map and many illustrations; it merits a favourable reception from the English reading public.

We have an evidence of the activity of research in the United States in the following list of American Microscopical Societies furnished by the *American Naturalist*:—Agassiz Institute, Sacramento, California; Academy of Natural Sciences, Philadelphia, Biological and Microscopical Section; American Association for the Advancement of Science, Microscopical Section; American Microscopical Society of New York; Bailey Club, New York; Boston Microscopical Society; Boston Society of Natural History, Microscopical Section; Dartmouth Microscopical Club, Hanover, N. H.; Fairmount Microscopical Society of Philadelphia; Indiana Microscopical Society, Indianopolis, Ind.; Kirtland Society of Natural History, Cleveland, Ohio, Microscopical Branch; Louisville Microscopical Society, Louisville, Kentucky; Maryland Academy of Sciences, Baltimore, Section of Biology and Microscopy; Memphis Microscopical Society, Memphis, Tenn.; New Jersey Microscopical Society of the City of New Brunswick, N. J.; Providence Franklin Society, Providence, N. J., Microscopical Department; San Francisco Microscopical Society; Society of Natural Sciences, Buffalo, N.Y., Microscopical Section; State Microscopical Society of Illinois, Chicago, Ill.; State Microscopical Society of Michigan, Kalamazoo, Mich.; Troy Scientific Association, Troy, N.Y., Microscopical Section; Tyndall Association, Columbus, Ohio, Microscopical Section. Eight of these societies have been established within the last two years.

We have received the Eighth Annual Report of the Perthshire Society of Natural Science, from which we regret to see that there has been rather a falling-off in the prosperity of the Society, arising mainly from indifference on the part of the majority of its members. In this, as in most other similar societies, the work is done by but a small portion of the members. Still the Society is working well in various ways, and this report contains a long and interesting address by the President, Sir Thomas Moncrieff, on the work done by the Society during the past year. We hope the publication of this Report will be the means of rousing a larger number of the members to take an interest in the work of the Society.

The Report for 1874, read at the thirteenth annual meeting of the West Riding Consolidated Naturalists' Society, embracing a large number of Field Clubs in the West Riding, is a very favourable one. At the time of the meeting, some months ago, the number of members was 545, and the Report states there is good reason to believe that studies in the various branches of Natural History are now diligently and earnestly pursued.

The additions to the Zoological Society's Gardens during the past week include a Black Ape (*Cynopithecus niger*) from Celebes, presented by the Hon. Evelyn H. Ellis; a West Indian Agouti (*Dasyprocta antillensis*) from Trinidad, presented by Mr. Christopher James; a Coypu Rat (*Myopotamus coypu*) from South America, presented by Mr. Robert E. Paton; a King Penguin (*Aptenodytes pennanti*) from the Falkland Isles, presented by Mr. L. Cobb; an Indian Cobra (*Naia tripudians*), two Russell's Vipers (*Vipera russelli*), three Carpet Vipers (*Echis carinata*), an Indian Eryx (*Eryx johnii*), an Indian Python (*Python molurus*), three Indian Rat Snakes (*Ptyas mucosa*), and five Long-snouted Snakes (*Passerita mycterizans*), from India, presented by Dr. John Shortt; two Rendall's Guinea Fowls (*Numida rendalli*) from West Africa, two King Parrakets (*Aprosmictus scapulatus*) from New South Wales, deposited; a Molucca Deer (*Cervus moluccensis*), born in the Gardens.

SCIENTIFIC SERIALS

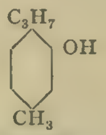
Journal of the Franklin Institute, April.—The following are the principal original papers in this number:—Report on a test trial of a Swain turbine water wheel, by J. B. Francis, C.E.—On the moments and reactions of continuous girders, by M. Merriman, C.E.—Compound and non-compound engines, steam jackets, &c., by C. E. Emery, C.E.; this is the first part of a paper presenting a discussion of the results of experiments made on several U.S. Government steamers.—First part of a paper on experiments made at the Mare Island Navy Yard, California, with different screws applied to a steam launch, to ascertain their relative propelling power, by Chief Engineer B. F. Isherwood, U.S.N.—New processes in proximate gas-analyses, by Prof. Henry Wurtz, continued from a former number.—On the cause of the light of flames, being a translation from the German of W. Stein, who discusses the results attained by Prof. Frankland.

Der Naturforscher, Feb. 1875.—This valuable publication contains abstracts of many important papers published elsewhere, most of which are noticed separately in NATURE; but there are also numerous original papers. We point out the following:—On the elements of the flora of the Chalk period, by C. v. Ettingshausen.—On the nature of lichens, by P. Magnus. This is an account of the difference of opinion existing amongst the authorities on the subject in question, some of whom do not think lichens uniform organisms, but rather suppose them to consist of a fungus which draws the greatest part of its organic substance from the Algæ (the so-called lichen Gonidia) round which it grows, while others do not agree with this view; the author, however, tends to the adoption of the idea as a correct one.—On the Biela Comet shooting stars observed by Herr Winnecke at Strasburg on Dec. 3 last.—On the revival of Rotifera, by Mr. Leidy.—On the atmospheric peroxide of hydrogen, by Herr Houzeau.—On the colour and specific gravity of sea-water; observations made on board the German Expedition corvette *Gazelle* on her voyage to the Kerguelen Island, under the superintendence of Herr von Schleinitz. These observations seem to show that the blue colour of sea-water stands in close relation with the quantity of salt the water contains, and that as the salt decreases the colour passes from blue to blue-green and dark green. There seems to be such regularity in this, that simply according to the specific gravity of the water the shade of colour could be determined which the water must show, and *vice versâ*. The transparency of the water seems also to increase with its quantity of salt; that of blue water was found to be 4·7 meters, while that of dark green only 2·5 meters.—On the nature and the laws of adhesion, by J. Stefan.—On the assimilation of nitric and sulphuric acids by germinating peas, by Herr Kellner.—New researches on some absorption phenomena of field-soils, by Herr Eichhorn.—On the spectra of comets, by H. C. Vogel, with special reference to Coggia's Comet.—On the copulation of spores of Algæ, by P. Magnus.—On the digestion of albumen, by R. Maly.—On a new method to investigate the nature of electric discharges, by Herr A. M. Meyer.—On a new theory of the sensation of light, by Herr E. Hering. This theory refutes that of Young and Helmholtz, which adopts three simple colours, red, green, and violet, and sometimes requires certain psychic processes for explaining certain facts. Herr Hering tries to do away with these processes in question.—On the new malleable glass, by Herr J. Fahdt.—On the decomposition of preserved wood, by Max Paulet.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Feb. 15.—This number contains an article on the universal meteorograph, by Prof. Van Rysselberghe, of Ostend. The instrument was fully explained by the inventor at a recent meeting of the Meteorological Society.

March 1.—The subject of rain and the barometric minimum is here further discussed by Prof. Reye, who finds that his views agree in the main with those of Herr Hann. Both these meteorologists recognise the latent heat of vapour as moving force in rotating storms; this causes the air to ascend and fresh air to be drawn in. According to Herr Hann, the barometer only sinks fast after a large whirl with a strong ascending current has been formed. Prof. Reye agrees with him in thinking that the rotatory movement contributes to rarefaction in the centre and thus renders possible the occasional long duration of minima. But he differs with him regarding another point. He considers that the ascending central current can only last so long as its temperature, derived from condensation, exceeds that of the surrounding air, and that this higher temperature must make pressure lower beneath the ascending current than around the cyclone. Dr. Hann, on the contrary, affirms that condensation has little effect on pressure, and that the minima of storm-centres are not caused by rainfall. Mohn's theory of the propagation of storms in the direction of largest rainfall cannot hold good if the latter view be correct. Loomis has shown how American storms generally move towards the area of greatest rainfall. Mohn finds from observations of 210 European stations that moisture is most prevalent on the front side of depressions. Thom testifies to the enormous rainfall accompanying storms in the Indian Ocean. Prof. Reye calculates that if it were possible for rain to fall to the amount of 1 mm. at any place without producing any indraught of air, the barometer would fall ⅞ of a millimetre, and generally in that proportion. Now, in hurricanes, such a condition is more nearly approached than in thunderstorms or steady rains. In the vortex, air and vapour rise so rapidly that they cannot part with much heat, and at the same time the inflow of the lower strata is retarded and the outflow of the upper strata accelerated by centrifugal force. There still remains, after liberated latent heat has been employed in expansion, a portion which has been disregarded, equivalent to the *vis viva* of the whirling mass and the work of expansion performed in ascending. With all this evidence he maintains his theory.—In the *Kleinere Mittheilungen* we have the last part of Dr. Ucke's paper on atmospheric oxygen, containing tables which give its variations in quantity at different seasons, with reference to the means of all stations together, and of the stations taken separately. At Seringapatam the difference between summer and winter is least, viz., 1 per cent.; London shows 4, Brussels 6, Vienna 8, Petersburg 9, Samara 14, and Barnaoul 16 per cent. Proximity of the sea and elevation obviously produce the low figures, and the more easterly a place lies on the continent the greater are the differences between the seasons.

THE *Gazzetta Chimica Italiana*, fasc. i. e ii. 1875, contains the following original papers, besides a great number of abstracts from other serials:—On two new derivatives of phloretic acid, by W. Koerner and P. Corbetta. These are researches on methyl- and ethyl-phloretic acids and their products of oxidation. The authors arrived at the conclusion that phloretic acid can most probably be regarded as phenolisopropionic acid of the formula $C_6H_4 . OH . CH \left\{ \begin{matrix} CH_3 \\ COOH \end{matrix} \right.$.—On the origin of the sulphides and hyposulphides found in natural sulphur waters, by Prof. E. Pollacci.—Researches on some derivatives from natural and artificial thymol, by E. Paterno. The author considers acetylic, methylic, ethylenic, and the sulpho-methylic derivatives of both thymols, and points out their differences.—On paratoluic nitride and some of its derivatives, by E. Paterno and E. Spica.—A note from Dr. M. Fileti, on a glucosate of copper.—Account of experiments made by the same author and E. Paterno, to obtain a carbo-cymenic acid. The experiments made until now with natural thymol and its artificial substitute obtained from cymene, show that both are hydroxyl derivatives of the same cymene, which upon oxidation gives paratoluic acid, and therefore contains the propyl and methyl group in the positions 1 to 4; the difference rests therefore only in the position of the hydroxyl, and as only the two following oxy-derivatives of parapropylmethylbenzine



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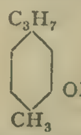

were possible, it remained to be decided which of the two formulæ applied to natural and which to artificial thymol. The nature of the cresols obtained by Engelhardt and Latschinoff, and by Kekulé, by the action of phosphoric anhydride on the isomeric thymols, has rendered it very probable that the first of the above formulæ represents the natural thymol, the other the artificial one. The authors made the experiments of converting sulpho-cymenic acid into carbo-cymenic acid, which has the following formula, $C_6H_3 \left\{ \begin{matrix} C_3H_7 \\ CH_3 \\ COOH \end{matrix} \right.$, and then tried to oxidise the latter, by which they would have finally solved the above question. They have not quite succeeded yet, although they hope to publish their final results shortly.—On the supposed emission of carbonic acid from the roots of plants, by M. Mercadante and E. Colosi. The authors pretend that no such emission exists.—The remainder of the number consists entirely of summaries from other journals, most of which we have already noticed.

IN the 2e fascicule of the *Bulletin de la Société d'Anthropologie de Paris* for 1874, M. Dareste concludes his reply to M. Broca's theory of the mode of formation of double monsters, considering them under the several types named by Isidore G. Saint-Hilaire, "janiceps, iniopes, synotes," and "deradelphes." In a later meeting of the Society, M. Broca entered at great length on the consideration of the "Doctrines of Diplogenesis," and endeavoured to show the untenability of the hypothesis which ascribes this abnormality to fusion rather than to excess of development, and an inherent tendency in the embryo to a repetition or doubling of parts.—A letter was read from M. Prunières, in which he describes the artificial perforations discovered by him in human skulls belonging to the period of dolmens. As early as 1868 the writer first drew attention to the numerous cases in which cranial and other human bones had been found bearing evidence of having been cut or perforated by instruments belonging to the polished stone age. M. Broca, in describing the crania submitted to his notice by M. Prunières, draws attention to a similar condition in a skull sent to him by Mr. Squier, and taken by the latter from an ancient Peruvian tomb, in which a square opening had been made, evidently by a saw, and probably a few days before death; and he mentions that among the Kabyles and other African tribes trepanning is resorted to in the present day for comparatively unimportant diseases, while Hippocrates refers to the process as one established in his time among the Greeks. M. Broca does not, however, assume that cranial perforations among primitive races in Europe had any connection with surgical processes, but is rather disposed to assume them to have been the result of certain obligations of religion.—M. J. de Baye describes circumstantially the caverns and recesses, amounting to more than one hundred, which he has recently discovered and explored in the Valley de Petit-Morin, in Marne.—M. Bertrand has presented the Society with a cast of a reindeer horn, on which is distinctly traced with a flint instrument the figure of a reindeer grazing, which was found at Thaïnghen, near Lake Constance.—MM. de Quatrefages and Hamy, in offering their colleagues the second edition of their great work on "Crania Ethica," which is entirely devoted to the consideration of the Cro-Magnon race, entered into an exposition of their views in regard to the relations existing between the Troglodytes of Perigord and certain southern races, including not only the Basques, but Kabyle tribes from the Beni-Menasser and Djurjura regions.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, May 13.—Prof. Cayley, F.R.S., vice-president, in the chair.—The Rev. C. Taylor read a paper on some constructions for transforming curves and surfaces. The basis of the paper was a neglected work on conic sections, "which for originality and thoroughness is in its own special department unsurpassed." The author was G. Walker, F.R.S., of Nottingham, and his work appeared in 1794. The tediousness of the style may account for the fact that the work was not appreciated. Dr. Hirst and the Chairman made some remarks on the paper.—Mr. J. W. L. Glaisher communicated some notes on Laplace's coefficients.—A short paper by Mr. Harry Hart, on a linkwork for describing sphero-conics and sphero-quartics, was taken as read.

Chemical Society, May 20.—Prof. Abel, F.R.S., president, in the chair.—Mr. A. H. Smee read some notes on milk in health and disease. From the results of numerous experiments he finds that when cows are fed on sewage grass alone the milk soon goes putrid, and the butter made from it is soft, and rapidly becomes rancid. He also noticed the outbreaks of typhoid which had occurred in various places owing to sewage water having been used to cleanse the dairy utensils or to reduce the quality of rich milk to the lowest standard permitted by law. A long and interesting discussion followed, after which Mr. W. H. Deering read a paper on some points in the examination of waters by the ammonia method, in which he proposes certain modifications to facilitate the application of the Nessler test and eliminate incidental errors. There was also a communication from Prof. H. Howe on some Nova Scotian Triassic Trap minerals.

Geological Society, May 12.—John Evans, V.P.R.S., president, in the chair.—The following communications were read.—Notes on the occurrence of *Eozoon canadense* at Côte St. Pierre, by Principal Dawson, F.R.S. The author commenced by describing the arrangement and nature of the deposits containing *Eozoon* at the original locality of Côte St. Pierre on the Ottawa River. The Eozoal limestone is a thick band between the two great belts of gneiss which here form the upper beds of the Lower Laurentian. *Eozoon* is abundant only in one bed about four feet thick; but occasional specimens and fragments occur throughout the band. The limestone contains bands and concretions of serpentine, and is traversed by veins of chrysolite; the former an original part of the deposit, the latter evidently of subsequent formation. A thin section, 5½ inches in depth, showed: (1) Limestone with crystals of dolomite and fragments of *Eozoon*; (2) Fine-grained limestone, with granules of serpentine, casts of chamberlets of *Eozoon* and of small Foraminifera; (3) Limestone with dolomite, and containing a thin layer of serpentine; (4) Limestone and dolomite with grains of serpentine and fragments of supplemental skeleton of *Eozoon*; (5) Crystallised dolomite, with a few fragments of *Eozoon* in the state of calcite; (6) Limestone containing serpentine, as No. 2. The author criticised some of the figures and statements put forward by Messrs. King and Rowney, and noticed two forms of *Eozoon*, which he proposed to regard as varieties, under the names of *minor* and *acervulina*. He stated that fragments of *Eozoon*, included in dolomitic limestones, have their canals filled with transparent dolomite, and sometimes in part with calcite. In one specimen a portion was entirely replaced by serpentine. The author called particular attention to the occurrence of serpentinous casts of chamberlets, single or arranged in groups, which resemble in form those of the Globigerine Foraminifera. These may belong either to separate organisms or to the acervuline layer of the *Eozoon*; the author proposes to call them *Archæospherinæ*, and describes them as having the form and mode of aggregation of *Globigerina*, with the proper wall of *Eozoon*. The author discussed the extant theories as to the nature of *Eozoon*, and maintained that only that of the infiltration of the cavities of Foraminiferal structure with serpentine is admissible. He particularly referred to the resemblance of weathered masses of *Eozoon* to Stromatoporoid corals.—Remarks upon Mr. Mallet's theory of volcanic energy, by the Rev. O. Fisher, F.G.S. Mr. Mallet's paper, read before the Royal Society in 1872, was discussed by the author *seriatim* as far as it seemed open to criticism. With respect to the condition of the earth's interior, whether it be rigid or not, Sir W. Thomson's arguments for rigidity were referred to, and geological difficulties in accepting his conclusions suggested. Mr. Mallet's views regarding the formation of oceanic and continental areas, that they have on the whole occupied nearly the same positions on the globe at all periods from the very first, were objected to on the ground that all continental areas with which we are acquainted are formed of water-deposited rocks, and that therefore those areas must at some time have been sea-bottoms; and if these wide features have not occupied the same positions which they now do from the very first, Mr. Mallet's explanation fails, that they were caused by unequal contraction when the crust was first permanently formed and thin. It was also shown that the theory of unequal *radial* contraction cannot account for the difference of elevation between continental and oceanic areas upon reasonable assumptions. For if we consider the crust to have been 400 miles thick (which cannot be considered *thin*), and to have cooled from 4000° F. to zero (a most extravagant supposition), then, if the crust had contracted one-tenth more beneath the oceanic area than it had done beneath the continental, we should only get a depression of one mile for the oceanic area, using Mr. Mallet's mean coefficient of contraction. The main feature of Mr. Mallet's theory was then discussed, viz., that "the heat, from which terrestrial volcanic energy is at present derived, is produced locally within the solid shell of our globe, by transformation of the mechanical work of compression or crushing of portions of that shell, which compressions and crushings are themselves produced by the more rapid contraction by cooling of the hotter material of the nucleus beneath that shell, and the consequent more or less free descent of the shell by gravitation, the vertical work of which is resolved into tangential pressures and motion within the shell." Mr. Mallet's mode of estimating the amount of heat derivable from crushing a cubic foot of rock was explained, and it was accepted as a postulate, that the heat developed by crushing one cubic foot of rock would be sufficient to fuse 0·108 of a cubic foot of rock; or, in other words, that it would require nearly the heat developable by crushing ten volumes to fuse one. Mr. Mallet considers that the heat so developed may be localised. But Mr. Fisher inquires why, since the work is distributed equally with the crushing, the heat should not be so also; and, since no cause can be assigned why one portion of the crushed portion of rock should be heated more than the rest, assumes that all which is crushed must be heated equally. In short, he is of opinion that if Mr. Mallet's theory were true, the cubes experimented upon ought to have been themselves fused. After paying a just tribute of admiration to Mr. Mallet's elaborate and highly important experiments upon the fusion and subsequent contraction of slags, the author remarked upon Mr. Mallet's estimate of the probable contraction from cooling of the earth's dimensions, showing that it had been based on untenable assumptions. (The author of the paper, however, holds that the contraction of the dimensions of the globe has been greater than *mere* cooling will account for.) Upon the concluding portions of Mr. Mallet's paper, in which he estimates that the amount of energy afforded by the crushing of the solid crust would be sufficient to account for terrestrial vulcanicity, some strictures were made; but it was held that, if the main proposition had not been proved, these calculations were not of essential importance.

Meteorological Society, May 19.—Dr. R. J. Mann, president, in the chair.—The following papers were read:—On some practical points connected with the construction of lightning conductors, by Dr. R. J. Mann. This paper dealt especially with the material and dimensions of conductors, the nature and influence of points, the essentials of earth contacts, connection with metallic masses forming a part of the construction of buildings, the power of induction in producing return shocks, the dangerous action of metal chimney-pots upon unprotected chimney shafts, and the facility with which houses may be efficiently protected when the defence is made part of the original design of the architect. The conditions which were finally insisted upon as indispensable to efficiency of protection were:—1. Ample dimension and unbroken continuity in the lightning rod. 2. Large and free earth contacts, with frequent examination by galvanometers of the condition of these to prove that they are not in process of impairment through the operation of chemical erosion. 3. The employment of sufficient points above to dominate all parts of the building. 4. The addition of terminal points to the conducting system wherever any part of the structure of the building comes near to the limiting surface of a conical space having the main point of the conductor for its height, and a breadth equal to twice the height of that point from the earth for the diameter of its base. 5. The avoidance of all less elevated conducting divergencies within striking distance of the conductor, and especially such dangerous divergencies of this character as gas-pipes connected with the general mains, and therefore forming good earth contacts.—On certain small oscillations of the barometer, by the Hon. Ralph Abercromby. These small oscillations of the barometer (sometimes called "pumping") have long been associated with gusts of wind, but the precise nature of their action has not been determined. The author gives two examples as typical:—1. Window looking S., wind nearly S., in strong gusts. In this case the first motion of the barometer was always upwards about 0·01 inch, as if the effect of the wind being arrested by the house was to compress the air in the room. 2. A corner house, one window to S., another to W., wind S. in strong gusts. With the W. window open there were violent oscillations, but in this case the first motion was always downwards. On opening the S. window as well, the pumping ceased. The explanation seems to be, that the wind blowing past the W. window drew air out of the room, but when the S. window was opened as much air came in as was drawn out, and the pumping ceased. It is well known to medical men that many acute diseases are aggravated by strong winds; and the author has observed this distress to be associated with the pumping of the barometer. He suggests the following practical methods of palliation:—If windows can be borne open, try by crossing, or otherwise altering the drafts, to diminish the distress. When, as in most cases, windows cannot be open, all doors and windows should be closely shut, as well as the vent of the chimney, if there is no fire; and, if possible, the patient should be moved to a room on the lee side of the house.—Proposed modification of the mechanism at present in use for reading barometers so that the third decimal place may be obtained absolutely, by Mr. R. E. Power.

PARIS

Academy of Sciences, May 10.—M. Frémy in the chair.—The following papers were read:—On the substitution by approximation within determined limits of the relation of variables of a homogeneous function to two variables of another homogeneous function of the same degree, by M. H. Resal.—A letter by M. Faye, on the distribution of temperature on the sun's surface and the recent measurements of M. Langley.—Observations on the Pandaneæ of New Caledonia, by M. A. Brogniart.—On a locomotive on stilts instead of wheels, by M. Tresca.—On a law connected with the work performed by steam-engines, by M. A. Ledieu.—The President then welcomed M. Fleuriais, the chief of the party of observers sent to Pekin to observe the Transit of Venus. M. Fleuriais then read a detailed description of the work done by the expedition and of the journey, which was accompanied by many difficulties.—Observations on the epoch of disappearance of the ancient fauna of Rodrigues Island, by M. Alph. Milne-Edwards.—Memoir on the formulæ of perturbation, by M. E. Mathieu.—On some properties of algebraic curves, by M. Laguerre.—On the toxicological effects of the bark of *Mancône*, by MM. Gallois and Hardy.—On observations made with different Phylloxera, by M. Lichtenstein.—The Minister for Public Instruction transmitted to the Academy a letter, dated Capetown, Feb. 22, 1875, from M. Lanen, and containing interesting data regarding the fauna and the flora of the Kerguelen Islands. These data are due to the observations made by Dr. Kidder, a naturalist who was attached to the Transit of Venus party sent to those islands by the United States.—A note by M. Garnier, on the use of glycerine in the treatment of glycosuria.—On the theory of storms, a reply to M. Faye, by M. Peslin.—On the presence of sulphuric anhydride in the gaseous products of the combustion of iron pyrites; note by M. A. Scheurer Kestner.—On the quaternary lignites of Jarville, near Nancy, by M. P. Fliche.—M. d'Abbadie then spoke on the first results of observations made by M. de Rossi, on the microscopical movements of freely-suspended pendula.—M. Virlet d'Aoust, in relation to the recent catastrophe with the *Zenith* balloon, pointed out the danger in the quick passage through strata of air of variable densities.

May 17.—M. Frémy in the chair.—The following papers were read:—Meridian observations of the minor planets, made at the Observatories of Greenwich and Paris during the first quarter of 1875. The planets observed were the following:—1, 46, 49, 59, 33, 24, 67, 15, 18, 94, 103, 109, 134, 7, 124, 25, 47, 53, 54, 73, 84, and 101. This communication was made by M. Leverrier.—Observations by M. Leymerie, on a note of M. Trutal relating to a Pliocene deposit in the Eastern Pyrenees.—On the swimming-bladder of *Caranx trachurus*, and on the hydrostatic function of that organ, by M. A. Moreau.—On chemical and physiological ferments, by M. A. Müntz.—Experiments and observations relating to glutinous fermentation, by M. A. Baudrimont.—A note by M. de Tastes, on the theory of cyclones.—Anatomical, physiological, and pathological researches on the human ovum in its relation to the diseases of the fœtus, by M. G. J. Martin Saint-Ange.—Observations of the moon and of moon culminating stars, made at Melbourne Observatory, by Mr. Robert Ellery (communicated by M. Leverrier).—On mercury-cataracts, by M. C. Decharme.—A note by M. de Fonvielle, on the precautions to be used when making balloon ascents to a great height.

BOOKS AND PAMPHLETS RECEIVED

Foreign.—Zeitschrift für Wissenschaftliche Zoologie: Carl Theodor von Siebold, Albert von Kolliker, und Ernest Ehlers (Leipzig, W. Engelmann).—Jahrbücher für Wissenschaftliche Botanik: Dr. N. Pringsheim (Leipzig, W. Engelmann).—Recherches sur les Phenomènes de la digestion chez les Insectes: Felix Plateau (Bruxelles, F. Hayez).—Le Scoperte del Fusinieri. Influence de la pression de l'air sur la vie de l'homme. 2 vols.: D. Jourdanet (Paris, G. Masson).—Der Venusmond und die Untersuchungen über die früheren Beobachtungen dieses Mondes: Dr. F. Schorr (Braunschweig, Friedrich Vieweg und Sohn).—Etudes Premières et Secondes sur les seiches du lac Léman: F. A. Forel (Lausanne, Rouge et Dubois).—Repertorium für Meteorologie: Dr. H. Wild (Russia).—Annales de l'observatoire Physique Central de Russie: Dr. H. Wild (Russia).—Traversée du Détroit par le Capitaine P. Boyton. (Boulogne-sur-Mer, Charles Aigre).

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THURSDAY, JUNE 3, 1875

THE ARCTIC MANUAL

Manual of the Natural History, Geology, and Physics of Greenland and the Neighbouring Regions. By T. Rupert Jones, F.R.S., and W. G. Adams, M.A., F.R.S. Edited by Prof. T. Rupert Jones, F.R.S., under the direction of the Arctic Committee of the Royal Society. (Published by Authority of the Lords Commissioners of the Admiralty, 1875.)

THE Arctic explorers, to whom we must all give a hearty God-speed now they have started on their journey, besides being supplied with "Instructions" as to the points on which information is most required, and as to the manner in which they may best obtain it, have had compiled for them a most comprehensive "Manual" of what has already been done with regard to the natural history and physics of the northern regions. The time devoted to this work has been short, but the compilers have made the most of it, and their names are guarantees that the information is as complete as possible.

The book consists of a series of reprints of the latest and most trustworthy papers that have been written on the various subjects included. No other form of "Manual" would have been half so useful, even if there had been time to compile it. The limited area within which the exploration is to be conducted has made it possible to include all these in one handy volume. What would not an ordinary naturalist give to have all the previous work that had been done upon the district he was visiting collected together for him, instead of his having to search for it over scattered volumes? and how much more valuable it would be if it were revised up to the latest date by the authors themselves. This is what has been done for the Arctic naturalists, who will be cut off for years from all books but those they take with them, and to whom this work will therefore be of inestimable value. Of course we are not to understand that all that has been written on the natural history and physics of the Arctic regions is here reproduced; that would have been impossible: but in the first part complete catalogues are given, without the descriptions of the genera or species that have been named from Arctic specimens; and the second part, to which less time has been allowed, and which is less complete, contains only the most important portions of the papers or works from which extracts have been made.

It is not the Arctic voyagers, however, who alone will benefit by this Manual. Those who will follow them in thought in their perilous but splendid undertaking will find their interest increased, if this be possible, by the many questions for solution which its perusal will raise in their minds, and they will the more easily compare what was known *before* the expedition with that which we hope will be known after its return.

We proceed to give our readers some idea of the contents of this "Manual." Although the list of papers is no doubt scanty compared with what might be formed of more temperate climes, many no doubt will be astonished that so much has been done in the natural history of these inhospitable regions, far more in proportion than the observations of physical data.

The first part, devoted to Biology and Geology, is divided geographically into three sections; the first, on West Greenland, including Davis' Strait, Baffin's Bay, Smith's Sound, and Kennedy Channel; the second, the Parry Islands and East Arctic America; and the third, East Greenland, Spitzbergen, Franz-Joseph Land, &c. All these between them have 111 illustrative papers, many being double ones. They are arranged in each section zoologically, the first paper being by Dr. Robert Brown, on the Mammals of Greenland, of which there appear to be thirty-one now known, exclusive of introductions by the colonists; all but seven of which inhabit the sea. This paper is followed by two others by the same author, published about the same time (1860), containing his accounts of the species and habits of the Whales, Seals, and Walrus. Many such accounts have been published; they are always read with interest, and we have no doubt much further light will be thrown by the expedition on these animals, some of which are as yet only known by their skulls sent home to museums. There are six species of Greenland Seals, all sufficiently distinct to be placed in different genera, though one is often confounded with another. The chief are the Common Seal (*Callocephalus vitulinus*), the Saddleback, the male and female of which are of different colours, the Grey Seal, and the Bladder-nosed Seal, the latter of which was till lately represented in the Zoological Gardens by a living specimen. There is also the Walrus, large numbers of which used to inhabit British waters during the crag period, but of which only two have as yet been brought alive to England, where they survived but a short time. The Cetacea are more numerous, having sixteen representatives, including the Dolphins and Porpoise. Dr. Brown gives interesting details respecting several of these, of which we need only mention the voracity of the Killer (*Orca gladiator*), out of whose stomach Dr. Eschricht took thirteen porpoises and fourteen seals, the voracious animal having been choked by the skin of a fifteenth. A case is known in which they attacked a white-painted herring-boat in the Western Islands, probably mistaking it for a Beluga or White Whale.

From the Mammals we come to the Birds, the notes on which are contributed in a separate paper by Prof. Alfred Newton, the list being compiled by him from all available sources. The number of true denizens reaches sixty-three, of which, however, only forty-seven occur within the Arctic circle, and not more than thirty-six, if so many, may be expected in Smith's Sound. These are printed in a thicker type to draw attention to them, and short notes are given by which they may be distinguished even by those observers who are not professed naturalists. Prof. Newton is very severe on the former expeditions for "so ingloriously missing their glorious opportunities" in ornithology, "through the absence of special naturalists;" but this will not apply to the present one.

For the catalogues of the Fishes and most of the remaining classes of animals we have to go to Denmark, Drs. Lütken and Mörch, of Copenhagen, being the chief authorities on these branches—and they have both revised their lists to the latest date. The former writer has in preparation an "Ichthyology of Greenland," and the list of fishes here given is only provisional till that is completed. The number reaches seventy-eight, the greater number of course being Teleosteans, and many inhabitants of great depths, and consequently rare in collections, eighteen only being well represented in those of Britain.

Dr. Mörch's list of the Mollusca, including land, freshwater, and marine forms, reaches a total of 216, which are arranged after his own modification of Latreille's classification. As this is not the classification usually adopted or known in England, it may be well to indicate it. The Mollusca proper are divided into five classes. The first, *Androgyna*, Mörch, includes the five orders: *Grophila*, Fér., or land shells; *Hygrophila*, Fér., or freshwater shells; *Ptenoglossata*, Trochsel; *Gymnobranchia*, Cuv.; and *Pteropoda*, Cuv. The second class, *Dioica*, Latr., is divided into the three orders, *Tænio-*, *Toxo-*, and *Rhachiglossata* of Trochsel, after the characters of their tongues. The third class, *Exocephala*, Latr., is divided in the same way, into *Rhipido-* and *Heteroglossata*; while the remaining two classes, *Cephalopoda* and *Acephala*, are undivided, although there are enumerated species of the different orders as usually distinguished in the latter class. The *Brachiopoda* figure for four species in addition to the above, under the title of *Brachionopoda*. The *Tunicata* number thirteen species, and require revision, while the *Polyzoa* mount to sixty-three. Of the Insects nothing is recorded since Schiödte's list in 1857 of 114 species; of Arachnida there are almost none but a few Acari. The list of Crustacea is a large one, and has been revised by Dr. Lütken for this Manual. The whole number is 184, of which no less than seventy are *Amphipoda*. Yet this list is plainly incomplete, the *Ostracoda* being represented by one species only, while in the next paper Dr. Brady enumerates twenty-four from their shells. The other classes of animals have similar lists. In the Annelids most families are represented by a few species; the various Entozoa are tabulated. The Echinoderms are thirty-four, containing only one Echinid: the remaining lists are short ones, except that of the fixed Hydrozoa, and the Sponges, which are pretty numerous. It is useless, of course, to catalogue "species" of Foraminifera, and only a few notes are accordingly given of the various generic forms which have been met with at various depths, with a description of the nature of the materials in which they occur.

From animals we pass to plants. The first paper is the well-known one by Dr. Hooker, "Outlines of the Distribution of Arctic Plants," from the Linnean Society's Transactions for 1861, which has been reprinted with little alteration, chiefly from want of time, the more recent discoveries being given in foot-notes. The list of flowering plants contains those from the districts of Arctic East America and Greenland only, which number 552, of which about two-fifths are Monocotyledons, and the remainder Dicotyledons. Mr. Taylor's paper, on the Plants of Davis' Strait, though without the generalisations of the former, gives more details on the habitats and localities of the specimens; but this paper also is one of old date (1862). The Cryptogams are enumerated in various papers on the several sections to which separate students usually devote themselves; the most important being Dr. Lindsay's, on the Lichen Flora of Greenland and other Arctic Regions, from the Transactions of the Botanical Society of Edinburgh for 1869. As lichens will grow where nothing else will, their various species may naturally be expected to make a large figure in an Arctic flora; and so they actually do, as they number by themselves half as many as all the flowering plants together. The Diatoms, which in their vast numbers cause the discoloration of some portions of the Arctic seas, form the subject of another interesting paper by Dr. Brown.

When we reach the portion of the Manual relating to Geology, we find some part of the information to be of very ancient date, belonging to the days of Flætz-Trap-Formation and other exploded terms, which now convey no information whatever. The interest of these papers, written by Sir Charles Giesecke in the beginning of this century, is mineralogical. He was a careful collector and diligent observer, and his records are still valuable. One of his chief discoveries was an easily fused mineral he named cryolite, which is now an abundant source of aluminium. To this two papers are devoted. Shortly following these we have Dr. Sutherland's paper, no less valuable because some twenty years old, on the Geological and Glacial Phenomena of the Coasts of Davis' Straits and Baffin's Bay, which contains many observations on the ice-phenomena both of small and large masses. The Miocene Flora of Greenland, so admirably described by Prof. Oswald Heer in his "Flora Fossilis Arctica," and catalogued in other works, cannot of course in a small Manual like the present receive more than a comparatively brief notice, nor can it be needed, as it is an essentially standard work. There is also a Cretaceous Flora catalogued from the "Kome Formation" of the north coast of Noursoak Peninsula. Undoubtedly the most interesting paper in this section is that of Prof. Nordenskjöld, extracted from the *Geological Magazine*, in which he gave an account of his fruitful expedition to Greenland in the year 1870. The united papers that detail his experiences are together of considerable length. He made one of the very few attempts that have yet been made to enter the great continental icefield, and succeeded in passing over thirty miles, the interesting details of the journey being here recorded; and much valuable information was thus obtained. The new expedition will have great opportunities of such explorations, which is a reason for regretting the absence from it of any professed geologist. Prof. Nordenskjöld gives an account also of the various strata of the coast, which exhibit beds of Cretaceous and Miocene age, with some basalts which are associated with them. One of the most interesting discoveries made by him was that of three large masses of meteoric iron at Ovifak, of which a woodcut and analyses are here given, with full accounts of its various points of interest. This latter recital is very naturally followed by that portion of Dr. Flight's recent contributions to the *Geological Magazine* on Meteorites, which relates to those found in Greenland. This contains the results of the newer Swedish Expedition of 1871, together with further details about the stones themselves, as compared with other meteorites. The two chief remaining papers in this division are, first, a valuable abstract of geological notes on Noursoak Peninsula and Disco Island, by Dr. Robert Brown, which is only just published in the Transactions of the Glasgow Geological Society, and contains a succinct account of the geology of that part of Greenland as made out by various explorers; and secondly, a collection of notes by Henry H. Howorth of the several observations that have established the fact of the rising of the circumpolar land.

We have now passed in review the chief portion of this Manual, which occupies 500 out of its 750 pages, and relates to that portion of the Arctic regions whither the explorers are in the first instance bound. The remaining portion of the Natural History division—occupied with Parry Island and East Greenland—consists of shorter papers and far barer catalogues. These perhaps require no observations beyond noticing the fact—recently pointed out also by Mr. De Rance in our columns—that the various geological periods are much better represented in these latter districts, there being Silurian, Carboniferous, Triassic, and Jurassic, as well as Cretaceous and Tertiary rocks; and consequently we have lists of fossils supplied with which any that may be discovered may be compared. The last of the Natural History series is an extract from Mr. Woodward's paper on Glaciation, the object of the insertion of which, as it is entirely theoretical, it is difficult to understand, unless it be to give the explorers some idea of the kind of questions on which some of their geological and glacial observations may be expected to throw light.

There are two things that strike one in reading these long catalogues—(1), that he must be a well-informed naturalist to whom many of the names which belong to all classes and kingdoms of life are anything more than names; and (2), arising from this, what an advantage there is in having specific names at least as far as possible descriptive.

The second part of the Manual, relating to Physics, requires of course less detail, and is included in a far smaller number of pages. It is not constructed on exactly the same plan as the first part, but consists in a great degree in descriptions of the observations and results, instead of reprints of the original papers; nor is it so exhaustive. It is divided into eight portions, relating respectively to Meteorology, Temperature of the Sea, Formation and Composition of Sea-water Ice, Tides and Currents, Geodesy and Pendulum Experiments, Observations on Refraction and on Air, Terrestrial Magnetism, and the Aurora Borealis. Under the head of Meteorology we have a few scattered notes on the results of the numerous previous expeditions with the thermometer, barometer, &c., and a valuable table on the mean temperatures of various stations for the several months of the year. The information as to the temperature of the sea is still more meagre, and it seems to us that more might have been included with advantage. The papers selected on the Physical Properties of Ice are extremely suggestive and valuable, consisting partly of observations in Arctic regions as to the freezing-points of sea-water, and the compositions of the resulting ice and the remaining liquid, and partly of similar experiments in the laboratory.

The information also on the tides and currents is pretty full, showing what methods have been adopted in various expeditions for determining the former accurately and with what results. There are also papers of suggestions as to the probable directions and amounts of both, and the best places for observation, and on the Meteorology and Hydrography of the Austro-Hungarian North Polar Expedition. The part on Magnetism is on the same model as the last mentioned, and is equally, if not more valuable. The last chapter, on the Aurora Borealis, is the best of all. Besides the ordinarily phenomenal observations already made, great attention is naturally paid to the spectrum of the Aurora, its connection with electrical discharges, together with Angström's views of its origin as explained in NATURE (vol. x. p. 246), and the opinions of Prof. Herschel and Mr. Capron, as well as those of MM. Lemström and Wijkander, deduced from observations made by them in the different Swedish expeditions, all of which are here given as fully as possible.

Such is the book with which, in addition to all others, the Arctic explorers are supplied. It is a library in one volume such as one does not often see. The mass of material it contains is something marvellous, and all is condensed as much as is advisable. The compilers must have had hard work, but they may congratulate themselves on the result. They have practically said to the Arctic voyagers—"This is what we have; go and obtain more for us." May they be successful, and return with a full cargo of information, which, if it were packed as tight as in this Manual, would not take up much room in comparison with its high value.

LAWSON'S "NEW GUINEA"

Wanderings in the Interior of New Guinea. By Capt. J. A. Lawson. With Frontispiece and Map. (Chapman and Hall, 1875.)

IT is not often that a work of fiction calls for notice in the pages of NATURE; but we have here an exceptional case. This book has been favourably noticed in some of the daily and weekly papers as a genuine narrative of travel and an addition to our knowledge of an almost unknown region, and it therefore becomes a duty to inform our readers that it is wholly fictitious. It is not even a clever fiction; for although the author has some literary skill and some notion of the character of savages, he is so totally ignorant of the geography and the natural history of the country he pretends to have explored, and so completely unacquainted with the exigencies of travel and exploration in trackless equatorial forests, as to crowd his pages with incidents totally unlike any that occur to the actual explorer, and with facts altogether opposed to some of the best established conclusions of physical geography. We proceed to give proofs of the accuracy of these statements. First, as to his geography. He starts from a point a little to the east of Torres Straits, of which he is so injudicious as to give the latitude and longitude (both to seconds) from his own observations. He also gives a map of his route, but without scale or meridian line. He describes himself, however, as travelling generally northwards with only such divergences as the country necessitated, and we may therefore take it that his route was nearly north, as it should have been to cross the island. But although he gives no scale to his map, he (again injudiciously) gives the dimensions of a large lake, along one side of which he travelled, as "between 60 and 70 miles long, 15 to 30 broad," which being laid down on his map furnishes an excellent scale, and shows that the total distance from his starting point in a straight line to the place he professes to have reached must have been somewhere between 560 and 620 miles.

Now, the total width of New Guinea is here 380 miles only, and the longest distance possible to go without reaching the sea is just about 620 miles, which takes you to the shores of Geelvinck Bay.

The centre of New Guinea is about 6° S. of the equator, and is almost certainly a forest region throughout and abundantly watered. In this equatorial belt all round the globe the temperature is not excessive, 96° or 98° being the extreme daily limit, while the nights are almost invariably cool (70° to 76°). The greater part of the country here described is, however, said to be open plains with only occasional forest tracts; water was not found for a whole day's journey, even at the foot of a mountain range 10,000 feet high, and the ordinary daily temperature is said to have reached 106° to 109° and 115° in the shade. He describes a terrific storm of hailstones as large as hens' eggs, not on the mountains, but in the low country about 7° S. latitude.

His mode of travelling is as extraordinary as his geography. After the statement that in the tropics "early morning and evening are the only times when it is possible to travel," he assures us that he started at 3 A.M., and in the evening continued his journey till 9 P.M. This gives two-and-a-half hours in the morning and the same at night of total darkness, in an unknown, pathless, tropical country, and he even ascends part of a dangerous mountain full of fissures and huge rocks, till nine o'clock at night! The country, too, was full of venomous snakes; and huge scorpions a foot long, whose sting was certain death, were very abundant; and as these last are nocturnal animals, travelling in darkness among fissured rocks and dense vegetation must have been exciting. But then we are told that he carried a lanthorn, and by means of this artificial illumination it is to be supposed the whole party made good progress and baffled the scorpions.

More marvellous still is the ascent of Mount Hercules, 32,783 feet high. He starts with one native from the foot of the mountain at 4 A.M., carrying "food, water, arms, and blankets," and ascends 14,000 feet by nine o'clock! At 15,000 feet they came to snow, but continued on for many thousand feet more, and by 1 P.M. had reached a height of 25,314 feet, the temperature being 22° below freezing. This is certainly good climbing, as it is just 4,000 feet higher than Chimborazo from the sea-level, and more than twice as high as Mont Blanc is above Chamouni. The Alpine Club must hide their diminished heads after this. Of course, having turned back at one o'clock, our travellers arrived safely at their camp at 7.30 P.M. A tinted view of this wonderful mountain forms the frontispiece to the book.

Having digested this Alpine feat as best we may, let us turn to Capt. Lawson's account of the natural history of the island. It may be premised, for the benefit of non-zoological readers, that New Guinea belongs to the Australian region, and that with the exception of bats and a wild pig, all the known mammalia are marsupials, four species of kangaroos, several species of *Cuscus* (an animal somewhat like an opossum), and some smaller marsupial forms being known. The coasts have been visited for centuries, and considerable excursions have been made in the interior of the northern part of the island, while the southern portions have also been several times visited by our various surveying parties. The islands all round it agree in this exclusion of all mammalia but marsupials. But Capt. Lawson tells us quite a different tale. He met with no solitary kangaroo or Cuscus all through New Guinea, but he everywhere encountered deer of several species, wild buffaloes, wild goats, wild cattle of a new species, hares, foxes, a wonderful new tiger, long-tailed monkeys, and huge man-like apes! Of birds we have, quite correctly, Cockatoos and Birds of Paradise, but along with these, pheasants, woodpeckers, and vultures, the two former not known within a thousand, the latter within two thousand miles of New Guinea. The natives, too, have great herds of hump-backed cattle, and far in the interior many of them speak Dutch!

Hardly less absurd are Capt. Lawson's wonderful hunting feats and hairbreadth escapes. The monkeys of New Guinea seem remarkable for waiting to be shot at, although, as the natives have guns and shoot them for food, they would in other countries have become wary. Yet our author goes out with a native chief to shoot monkeys, and in a couple of hours they bag a score and wound several others. Again, in an hour's shooting he kills "thirty-nine ducks, five ibises, two storks, seven kingfishers, and three new birds." The deer are seen in "herds of two or three hundred," the wild goats generally go in "flocks of seventy or eighty!" A herd of at least ten thousand buffaloes was seen, and in a single tree more than a thousand hanging nests of one species of bird were counted, each nest, too, containing several distinct families. Capt. Lawson is tossed and then trampled on by a wild buffalo, and when recovered so that he could "walk a few paces, leaning on the arm of one of his attendants," he goes fishing, and in two hours "pulled out over a hundred fish, the largest a yard long," not to mention many large fish which broke away from the hook. A huge New Guinea tiger gets him in its clutches, but though the animal was larger than a Bengal tiger, he of course escapes, though "drenched with the Moolah's blood." He preserves the skin, which is "marked with black and chestnut stripes on a white ground," and this skin is "one of the few specimens he has succeeded in bringing to Europe." Wonderful birds, snakes, and insects are also described, sometimes very minutely, but not one of them at all resembles any of the known denizens of New Guinea. Here is a butterfly for example: "The largest specimen I obtained, whose wings measured exactly twelve inches across, was black, with a red border to the wings and red bands round the body. In the centre of each wing were three light blue spots arranged in a triangle. The body of this fly was as thick as my thumb, and six inches in length. The feelers were twelve inches in length, *and curled into three coils.*"

As if to complete his own refutation, our author states that he returned to the coast with a party of natives who were conveying, among other merchandise, skins of "birds, monkeys, &c.," and that two or three Dutch traders, as well as many Malays and Chinese, come there every year. This part of New Guinea is therefore in constant communication with the rest of the world, yet the existence in the island of monkeys, apes, deer, buffaloes, goats, and tigers, has remained totally unknown till the secret was revealed to us by this enterprising and veracious traveller.

ALFRED R. WALLACE

OUR BOOK SHELF

Vestiges of the Molten Globe. By W. L. Green, Minister of Foreign Affairs to the King of the Sandwich Islands. (Stanford and Co., 1875.)

IT is a pity that books of this sort are published, as they can do no good. It is one of that class which attempts to account for the general features of the earth by some extravagant hypothesis, for the proof of which some superficial observations of well-known facts and some show of quotations from well-known writers are all that is offered. Who besides the author can believe that the shape of the earth, deprived of its oceans, would be a tetrahedron, the four angles representing the four continents? Yet the author announces himself as following in the footsteps of Elie de Beaumont in his theory of the *réseau pentagonal*, as the following lucid sentence on page 2 shows:—"The form (of the earth) is included in his *réseau triangulaire*, and is, as I propose to show, the six-faced tetrahedron; the easterly sag or twist of the southern hemisphere on a twin plane, the apparently macled form of the crystal, having caused the lines of relief and depression of the earth's surface to elude solution whilst the *réseau* of that crystal in its simple form alone was applied to them." We quite agree with the author that "only the imperfection of the ideas or of the language in which they are conveyed can prevent the following pages being intelligible to every reader." However untenable De Beaumont's theory was, it was conscientiously and laboriously worked out, and the conclusions were commensurate with the offered proof, even if they were erroneous; but Mr. Green, who would be his follower and improver, jumps to conclusions far wider on the basis of supposition only. The present short volume is only the first part of three that are promised on the figure of the earth, volcanic action, and physiography; and we must hope that the second part, at least, which is to contain "observations of the great active volcanoes and the great extinct volcanic range of the Hawaiian group," which the author must have had good opportunities of making, will be somewhat more solid than this first. Mr. Green is plainly capable of better things than wild speculation, which anyone can make and no one can prove. There are no doubt many remarkable features in the distribution and shape of land and the direction of its coast lines, some of which are here pointed out; but the meaning of these things will only be arrived at by a wider knowledge of facts and sober induction from them. The large map that accompanies the volume shows some of these features well, and is beautifully executed.

Stanford's Elementary Atlases. I. Physical Atlas (sixth edition); II. Outline Atlas; III. Projection Atlas; IV. Blank Sheets for Maps. By the Rev. J. P. Faunthorpe, M.A., F.R.G.S. (London: Edward Stanford, 1875.)

THIS is really an admirable apparatus, not merely for the purpose of teaching the construction of maps, but for the giving of a real knowledge of what Physical Geography means, and for the conveyance of an impressive idea of the prominent physical features of the particular countries embraced in the set of maps. There are sixteen maps altogether, and in the Physical Atlas the chief physical features of the various countries are clearly brought out—mountain ranges, table-lands, and river-courses. The mountain ranges are simply but sufficiently indicated by thick lines, the principal summits being shown by small circles; the table-lands are shown by simple shading. Besides these features, each map contains one or more of the principal cross-sections of the country, which convey a vivid idea of its conformation. Prefixed to the Physical Atlas are a few useful hints on Map-drawing, on Mercator's Projection, on the Shape and Position of the Land Masses, and a few notes illustrating each map. Atlases II., III., and IV. are intended to lead the student gradually to skill in map-drawing, and are well calculated to serve the purpose. Anyone who goes faithfully through the course indicated by this excellent set of books will have a more real knowledge of the main features of the land-masses of the globe than any amount of mere reading can give. The fact that the Physical Atlas has reached a sixth edition, which contains several new maps and additional letterpress, proves that Mr. Faunthorpe's design has been appreciated.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Meteors of November 14

THE writer some time since called attention to the fact that the dates of certain meteoric showers, given by Humboldt and Quetelet as belonging to the November stream, indicated the existence of two distinct and widely separated clusters moving in orbits very nearly identical. The years thus designated were 1787, 1818, 1820, 1822, 1823, 1841, and 1846. As the last two were subsequent to the great display of 1833, the meteors seen were noticed only in consequence of their being specially looked for; and as the number conformable to the radiant of the Leonids is not given, there may be some doubt whether those observed really belonged to the November stream. The former displays occurred before the periodicity of such phenomena had been suspected, and the number of meteors would seem to have been considerable. As the shower of 1787 preceded by twelve years the great meteoric fall witnessed in South America by Humboldt, the group from which it was derived had passed beyond the orbit of Saturn at the time of the latter display. The phenomena of 1818, 1820, 1822, and 1823 indicate that, as in the case of the major group, which passed its descending node between 1865 and 1870, the meteoroids are extended over a considerable arc of their orbit. From November 1787 to the middle of the nodal passage of 1818–1823, is about 33½ years—a period nearly the same as that of the principal cluster. These facts alone were regarded by the present writer as giving reasonable probability to the hypothesis of an approximate identity of orbits. In NATURE, vol. xi. p. 407, it was shown that the meteor-showers of October 855 and 856 were probably derived from the stream of Leonids, and it is certainly remarkable that the interval from 855 to 1787 is equal to twenty-eight periods of 33·293 years. Again, the shower observed in China, Sept. 28, A.D. 288, making proper allowance for the nodal motion, corresponds to the same epoch; the interval between 288 and 855 containing seventeen periods of 33·35 years. In view of the fact that the shower from this cluster was due between 1851 and 1855, the following extract from the writer's note-book is not without interest:—

"Newark, Delaware, Nov. 13, 1852. . . . On the evening of the 11th, from 7 to 10 o'clock, an aurora borealis of ordinary brilliancy was constantly observed. About midnight the sky became overcast with clouds, thus preventing our watch for meteors which we were about to commence. On the 12th, from about 3 to 9 o'clock A.M., rain fell almost incessantly. About noon the clouds broke away, and the night between the 12th and 13th was quite clear. During six hours—from 10 P.M. to 4 A.M.—constant watch was maintained at four windows, facing north, south, east, and west. From 10 to 1 o'clock the observations were conducted by Prof. Ferris and myself with assistants. At 1 the place of Prof. Ferris was taken by Prof. Porter, who remained, with myself and assistants, till 4. We observed—

From 10h. to 11h.	... ...	20 meteors.
,, 11 ,, 12	... ...	35 ,,
,, 12 ,, 1	... ...	40 ,,
,, 1 ,, 2	... ...	52 ,,
,, 2 ,, 3	... ...	75 ,,
,, 3 ,, 4	... ...	59 ,,
Total	... ...	281

When the meteors were most numerous, near 3 o'clock, the common point of divergence in Leo was distinctly observed."

I may here add, although the fact is not stated in my memoranda, that the conformable meteors, or a majority of them, were seen near the radiant, and that they were generally smaller and had shorter tracks than the November meteors observed between 1865 and 1870. The number seen was too small to be called a shower; at the maximum, however, the fall per hour was nearly double that of ordinary nights. In short, I have no doubt that they were Leonids, and think it highly probable that they were derived from a distinct cluster which passed its perihelion in 1787 and 1820. We have therefore nine recorded meteor-falls which indicate the existence of a second cluster of Leonids, viz., those of A.D. 288, 855, 856, 1787, 1818, 1820, 1822, 1823, and 1852. The showers of 855 and 856 may be somewhat doubtful. If derived from the same meteor-cloud as the others, the dates would indicate considerable perturbations either by Uranus or the earth. The displays have been much less conspicuous than those of the major group, and hence the phenomena have been less frequently observed. The period is about 33·33 years, while that of the other swarm, according to Newton, is 33·25 years. Since their separation, therefore, the latter has gained nearly two-thirds of a revolution in their relative motion. The estimates which have been made in regard to the recent entrance of the cluster into the planetary system must consequently be rejected. DANIEL KIRKWOOD

Bloomington, Indiana, U.S.A., April 20

Systems of Consanguinity

IN NATURE, vol. xi. p. 401, I find a notice of the third edition of Sir John Lubbock's valuable work on the "Origin of Civilisation," in which the following paragraph occurs:—"The facts with which he deals in this chapter [a new one in that volume] have been taken from the voluminous work of the American author, Mr. Morgan; but Sir John Lubbock, putting aside Mr. Morgan's theorising, has submitted a view of them of his own. This, in the main, and as far as it goes, we think, he has made out."

In the same article the following paragraph also occurs:—"One of Mr. Morgan's theories (for he has, or seems to have, two which it is no business of ours to reconcile with each other) is, that these systems are, to use the words of Sir John Lubbock, 'arbitrary, artificial, and intentional.'"

These statements, to the last of which with your permission I desire to reply, present the "American author" both harshly and unfairly to the British public. The interpretation of these systems of consanguinity, thus ascribed to me, is not mine; neither is the interpretation given in my work on "Systems of Consanguinity."

There are three or four places, and perhaps more, in that volume in which I speak of the system of a particular people as "artificial and complicated," and as "arbitrary and artificial," without the qualification in each case which should, perhaps, have been inserted. Thus, commenting on the same system (Con. p. 392), I remark that "the chain of consanguinity has been followed with great particularity, that the artificial and complicated character of the system might be exhibited, as well as the rigorous precision with which its minute details are adjusted." One who had read my work through could not have been misled by this statement, which was intended to characterise this system as it appeared on its face, and apart from all considerations respecting its origin. On the next page but one (p. 394) the same statement is repeated and qualified as follows: "As a plan of consanguinity it [the same system] is stupendous in form and complicated in its details; and seemingly arbitrary and artificial in its character when judged by ordinary standards."

In a single and final chapter of that work (pp. 467-510), entitled "General Results," I discussed the three great systems of consanguinity found in the principal families of mankind, and indicated some of the general conditions they seemed to warrant. My interpretation of these systems will there be found. To this chapter a person would naturally turn if he wished to know the views of the author on the precise question whether the systems were to be regarded as artificial or natural. Among other things, it contains what is prudently called a "conjectural solution" of the origin of the Malayan system of consanguinity, and also a similar solution of the origin of the Turanian system. These solutions are presented and discussed in connection with a series of fifteen prominent institutions and customs of mankind, articulated in a sequence in the order of their probable origination. It commences with "I. Promiscuous Intercourse"; "II. Intermarriage, or Cohabitation of Brothers and Sisters;" and ends with "XV. The Overthrow of the Classificatory System of Relationship, and the Substitution of the Descriptive." In it are enumerated several successive forms of marriage, several successive forms of the family, and the three systems of consanguinity in their order of relation. It was designed to illustrate the course of human progress from savagery to civilisation; one form of marriage being followed by another, one form of the family by another, and one system of consanguinity by another. It is a sequence of human progress through the slow accumulations of experimental knowledge.

At the end of the solution of the origin of the Malayan system, which is founded upon the assumed intermarriage of brothers and sisters in a group (the second member of the sequence), occurs the following statement (p. 482):—"Every blood relationship under the Malayan system is thus explained from the nature of descents, and is seen to be the one actually existing, as near as the parentage of individuals could be known. The system, therefore, follows the flow of the blood, instead of thwarting or diverting its currents. It is a natural rather than an arbitrary and artificial system." The reader will notice that it was this form of marriage which created the Malayan system.

Again, at the end of the solution of the origin of the Turanian system, and after showing that the latter was derived from the Malayan, occurs the following statement (p. 486): "If the progressive conditions of society during the ages of barbarism, from which this solution is drawn, are partly hypothetical, the system itself, as thus explained, is found to be simple and natural instead of an arbitrary and artificial creation of human intelligence."

In prosecuting this investigation one of the questions to be determined was whether these systems were artificial or natural. If the former, they are without ethnological value; but if natural systems, showing the relationships which actually existed when they were respectively formed, then they would possess immense value, because they concerned and demonstrated a condition of ancient society of which previously we had no definite conception. From each system, in such a case, can be deduced, with almost unerring certainty, the form of marriage and of the family in which it originated. It was by this course of reasoning that I discovered the necessary antecedent existence of the intermarriage of brothers and sisters in a group to account for the existence of the Malayan system of consanguinity. This fact gives us the starting-point in which ancient society commences, with the proof that it did so commence. Hence the second member of the sequence above-named. This sequence on its face, and these solutions in express terms, treat these systems as natural in every respect.

In an address before the London Anthropological Institute in 1871 upon the contents of the same volume on Consanguinity, Sir John Lubbock places me in the same position, and leaves me there. He remarks in that address (Journal of A. I., 1871, p. 6), which I presume forms the basis of "the new chapter," that "Mr. Morgan, from several passages, appears to regard the system as arbitrary, artificial, and intentional;" from which he takes occasion to dissent. I find in that somewhat elaborate address no reference whatever to the solutions named, and none whatever to the sequence. I am persuaded they must have escaped his notice. LEWIS H. MORGAN

Rochester, New York, April 19

The Migration of Species

IT has probably been the experience of most who have undertaken a voyage to sea, to have observed land-birds and insects far from the nearest coast, either in course of transit or resting on the vessel. Many travellers have observed these visitants, and their records have proved valuable biological facts bearing on the occasional migrations of species and their consequences as has been pointed out by Mr. Darwin. But it is more than probable that this dispersal of land species over extremely wide areas of sea is far more constant and less occasional than we are at present justified in affirming from the facts as yet collected. Unfortunately, however, we glean very little biological information from the great mercantile marine service of this country, an assemblage of which we are so justly proud, and it is only by costly Government expeditions that we become acquainted with facts that remained and would have remained unnoticed by the immense number of sailors who leave our shores. Nor can we feel surprised at the result when we recollect that biology is scarcely a subject thought necessary to form part of a mariner's education. A good instance is afforded by the results of the voyage of the *Beagle*. An impalpable powder fell upon the ship off the Cape de Verd Islands. This powder must have fallen upon many ships before; but Mr. Darwin being on board the

Beagle, it was collected and sent for inspection to Ehrenberg, and results of great scientific value accrued. Had our great philosophic naturalist not been there, this dust might still have fallen on ships to the present day, been swept away as a nuisance, and unrecognised as of any possible interest. That errant species must frequently visit vessels was shown me on a voyage to the East a few years ago. Thus, in the early part of September, in about lat. 12° N. and long. 26° W., a dove flew on board, which, after resting for a short time, again pursued its journey. In about lat. 9° N. and long. 25° W. a moth, apparently *S. convolvuli*, reached the vessel just before the arrival of a squall. In reply to my inquiries, both the officers and crew stated that these were simply very common occurrences.

I think we may feel confident that most vessels sailing this course meet frequently with like objects, and the interest would be increased by finding whether the same were observed by vessels still further from the nearest land. Could some means be devised for obtaining records of these migratory species, or could some large shipowner be induced to have the same carefully recorded in the log-books kept on board his vessels, I feel little doubt that we should be astonished by the number and constancy of these wanderers from other lands. The entry in the log-book would ensure the date and approximate latitude and longitude which would be necessary factors in dealing with this biological question, and would doubtless bear further proof to Mr. Darwin's view of colonisation by chance or occasional visitants.

So much might be done by some of our present means of unendowed research that it seems weary waiting for the day when a broader education will tend to induce our sailors to reap that abundant harvest of scientific information which they so constantly have the means of acquiring. There is surely some branch of science which might be indebted to every vessel that sails from this country on a foreign voyage, could the preliminary information and impetus for inquiry be given to the officers or crew. I believe the "Religious Tract," or some kindred society, provides many of our vessels with devotional literature; could not our learned societies also compile and provide some scientific works and questions for solution which might be placed in the hands of our sailors, thus affording a pleasure for a long voyage, and producing effects to be appreciated by science at home?

We should not expect the results of a "*Challenger* Expedition," but then Government outlays for that purpose are sometimes few and far between. W. L. DISTANT

Streatham Cottage, Buccleuch Road, West Dulwich

Muraenopsis tridactyla

WITH reference to Mr. Kent's letter in your last number (p. 69), I beg leave to point out to you that it is very doubtful, according to the best authorities, whether the so-called *Muraenopsis tridactyla* is even *specifically* different from *Amphiuma means* (*i.e.* the two-toed form of the same animal). Of the latter this Society have had several living specimens in their collection. One of them (purchased December 6, 1870) is still living in the Society's Gardens. P. L. SCLATER

Zoological Society of London

Hardened Glass

THE account of hardened and malleable glass given in NATURE, vol. xi. p. 474, interested me greatly.

It seems hardly possible that a change in the molecular constitution of glass can take place without affecting its optical properties. May not this glass, therefore, possess refractive and dispersive powers unlike those of the kind usually employed in lenses? If it can be made of sufficient purity and is found to have a higher refractive power, it will enable us to make thinner lenses with smaller curves, thus contributing to the further improvement of optical instruments. JAMES H. LOGAN

Jacksonville, Illinois, U.S.A., May 6

Yorkshire Exhibition "Guide"

WILL you kindly allow me, as a member of the Science Committee of the Yorkshire Exhibition of Arts and Manufactures, held at Leeds, to point out that the Yorkshire "Guide" referred in NATURE, vol. xii. p. 76, is entirely an unofficial publication. No competent member of the Committee was applied to for information respecting palladium or any other exhibit. The first intimation the Committee had of the wild statements contained in the "Guide" was received from a member who purchased a copy in the usual way, and immediate steps were taken to secure that more trustworthy information should be contained in future editions of the "Guide," unofficial though it be. You will, I think, see that it is rather hard that the Committee should, as by inference they may be, be made responsible for the statements you indicate, and will, I hope, give me space for this repudiation of them.

H. POCKLINGTON

Primroses and Cowslips

IN answer to Mr. J. J. Murphy's inquiry in NATURE of May 13 (vol. xii. p. 34) I beg to state that the locality in which, as far as I am aware, no primroses are found, is formed by the outcrop of the chalk in the south of Cambridgeshire and north of Hertfordshire, and is bounded on the north and south by the outcrop of the chalk marl and the edge of the London Basin, and east and west by the Great Eastern and Great Northern main lines; it is, from the nature of the underlying beds, very dry. I have always thought, but perhaps without foundation, that primroses are not generally found in the districts in which cowslips are common, and *vice versâ*, and Mr. Murphy's remark seems to bear out this.

I have not noticed any instance of the removal of the ovules of cowslips by birds; and even primroses, in other parts of the garden than those first attacked, have been left untouched.

Odsey, near Royston, Herts H. GEORGE FORDHAM

OUR ASTRONOMICAL COLUMN

THE MELBOURNE CATALOGUE.—We have received the "First Melbourne General Catalogue" of stars, which is founded upon the observations taken with the Transit Circle under the direction of Mr. Ellery, the Government Astronomer, at the New Observatory of Melbourne, between the middle of the year 1863 and the end of 1870. It has been reduced and prepared for publication by Mr. E. J. White, the first assistant, from the materials printed in vols. ii. iii. and iv. of the Melbourne Observations. Vol. i. contained a catalogue of 546 stars resulting from the meridian observations taken previous to the removal of the Observatory to its present site, and called the "Williamstown Catalogue:" in the new publication we have the positions for the beginning of 1870, of 1227 stars, with few exceptions observed at least three times, and accompanied by the terms of precession to the third order, proper motions, and Bessel's reduction-constants (as in the British Association Catalogue), with the synonyms in Lacaille, Piazzi, Brisbane, and Johnson. Great care appears to have been taken in calculating the precessions from the mean year of observation to the epoch of the catalogue, and a detailed account of the process employed is given in the introduction. The proper motions of the stars have also been discussed where the means were available, the more uncertain results being distinguished from those possessing greater claim to acceptance by enclosure in parentheses.

Many of the most interesting stars of the southern heavens are included in this Catalogue, and we note that the remarkable one ε Indi has not been overlooked. In this case the recent Melbourne observations, as compared with Jacobs' at Madras in 1852, assign an annual proper motion of 4″·58 in arc of great circle, thus quite confirming values previously obtained from less reliable data. We hope that at no distant period an attempt will be made to determine the parallax of this star. Large proper motion is indicated for the stars B. A. C. 5719, Aræ, and 7816, Indi; but on comparing the Melbourne positions with those in Gilliss's Santiago Catalogue, in the Washington volume of observations for 1868, not mentioned by Mr. White amongst the authorities he had consulted, it is not confirmed in either case.

The "First Melbourne Catalogue" is a handsome specimen of typography from the Government Printing Office. It must form an essential work of reference for every southern astronomer, who has now, with the "Cape

General Catalogue," two authorities supplying him with excellent positions of a large number of stars.

The Comet of 1533.—In the catalogues of the orbits of comets we find two sets of elements for this comet, both deduced from the observations of Apian between July 18 and 25, which are contained in his rare work, *Astronomicum Cæsareum.* The first orbit is by Douwes, who assigned *retrograde* motion, but in the *Berliner Jahrbuch* for 1800, Olbers gives another orbit, equally satisfactory as regards representing Apian's observations, in which the heliocentric motion is *direct*, and he appeared to think it was not possible to decide which of the two is to be preferred. In addition to Apian's account of this comet we have a brief one by Gemma Frisius, who states that after having been seen about the beginning of July in 5° (or rather, as Pingré corrects him, in 15°) of the sign Gemini, near the star Capella, with 24° of latitude and 48° north declination, it passed by a westerly motion, or contrary to the order of the signs, to the constellation Cassiopea, which it traversed, finally disappearing in Cygnus. Fracastor has also left us an account of the comet's track, though there is some ambiguity about it. Since Olbers calculated the orbit the Chinese observations have been published, in the first instance by M. Edouard Biot, in the additions to the *Connaissance des Temps* for 1846, and more recently in Mr. Williams' work upon Cometary Observations in China, and it would appear that the comet moved to the vicinity of π Cygni, and was last seen on Sept. 16. If we compare the elements of Douwes and Olbers with the track thus roughly defined, we see that the retrograde orbit of Douwes is hardly probable, and that possibly a modification of the direct orbit of Olbers would be found to sufficiently represent the path of the comet, according to Apian, Gemma, and the Chinese Annals.

Occultation of Venus.—Mr. R. Meldola, of the Royal Society Eclipse Expedition, writes that the occultation of May 2 was partially observed by Prof. Tacchini and himself from the P. and O. steamer *Peshawur* in the Arabian Sea. The moon was obscured by clouds at the time of immersion; the last contact took place at 16h. 15m. 6s. local mean time. Ship's position furnished by Capt. White—long. 77° 3′ E., lat. 6° 48′ 18″ N.

OUR BOTANICAL COLUMN

Phenomena of Plant-life.—The expansive power of growing vegetable tissue is something marvellous, if the experiments undertaken by Mr. Clark, president of the State Agricultural College of Massachusetts, are perfectly trustworthy. If his appliance for measuring the force exerted by a growing pumpkin was not at fault, the greatest weight lifted by the pumpkin in the course of its development was nearly two-and-a-half tons. Apparently the greatest care was taken to arrive at the truth, and we have no reason to doubt the accuracy of the statements contained in Mr. Clark's paper which was presented to the Massachusetts Board of Agriculture. But in our ignorance of the phenomena of plant life we should like to see the observations repeated. At the end of the experiment alluded to the soil was carefully washed from the roots of the pumpkin vine, and the entire system of roots spread out upon the floor of a large room and carefully measured. In addition to the main root, roots were formed at each joint or node. The total length of root developed was calculated to be over fifteen miles; and the time the plant was growing, four months. During the greater part of the time, of course, the rate of growth was relatively slow, but the maximum rate was computed at not less than one thousand feet of root per day.

With another plant of the same species, *Cucurbita maxima*, an experiment was instituted to ascertain the pressure exerted by the rising sap. For this purpose the plant was cut off near the ground, after it had attained a length of twelve feet, and a mercurial gauge attached to the part left in the ground. The maximum force with which the root of the pumpkin exuded the water absorbed by it was equal to a column of water 48·51 feet in height.

Some experiments to determine the channels through which the crude sap rises, and on the diffusion of the elaborated sap, gave interesting results. Mr. Clark says: "We find that the crude sap imbibed by the root-hairs from the surface of the particles of the soil seems to be taken up in a dry state; that is, it appears to be absorbed molecule by molecule, no fluid water being visible, and carried in this form through all the cellulose membranes between the earth and leaf, by which it is to be digested or exhaled. We do not say this is literally true, but it accords very nearly with what is constantly to be seen in some species of plants. The circulation of the sap in a poplar tree is very dry compared with that of the blood of any animal. Not a drop of moisture will ever flow from the wood of an aspen, so far as we have observed." It was found that an exceedingly small proportion of sapwood sufficed to convey the necessary supply of crude sap to the foliage, but none would ascend through the bark.

The quantity of sap that flowed from different trees during the season varied greatly in diverse species. Thus the entire flow from the bitter-nut was less than the product of the sugar-maple for a single day; but the ironwood and the birches surpass the maple in the rapidity and amount of their flowing. A paper-birch, fifteen inches in diameter, bled in less than two months over one thousand four hundred and eighty-six pounds of sap; the maximum flow, on the 5th of May, amounting to sixty-three pounds and four ounces. The grape bleeds comparatively little as compared with many other things. A very large proportion of the trees experimented upon did not show any tendency to bleed in spring. We might extract many other interesting details from Mr. Clark's paper, had we sufficient space for them.

PHYSICS IN GERMANY

(*From a German Correspondent.*)

HERR STEFAN, of Vienna, has published a paper on a series of researches on adhesion. It is well known that two plane plates which are placed upon one another adhere together so firmly that they can only be separated by a certain amount of force. This phenomenon has hitherto been considered as caused by adhesion (*i.e.* by the action of molecular forces between the particles in contact between the two plates), and it was tried to determine the magnitude of this adhesion statically.

The improbability of this conception already follows from the fact that in the case in question no immediate contact of the two plates takes place, but that between them there is a layer of air of considerable thickness. If two glass plates are employed for this experiment, they do not show Newton's coloured rings; these can only be produced with plates that are perfectly plane and with the application of considerable pressure. If, therefore, molecular forces were active in this case between the particles of the two plates, then the molecular sphere of action would have to be very much larger than is generally adopted according to other experiments. The phenomenon becomes still more striking if the experiment is made under water. In that case an attraction in the two plates can still be perceived, even if they are a millimetre apart. Herr Stefan used for his experiments two plates of glass, of which one was suspended from a balance in such a manner that its inferior plane was horizontal. The balance was then brought to equilibrium. The second plate was also placed horizontally under the other one. Three little pieces of wire were then placed upon it, and the upper plate was then let down so far as to rest upon these pieces of wire. By varying the thicknesses of the wires the distance of the two plates could be brought to any desired magnitude. To tear away the upper plate from the under one, it was necessary to place a certain over-weight into the other scale of the balance.

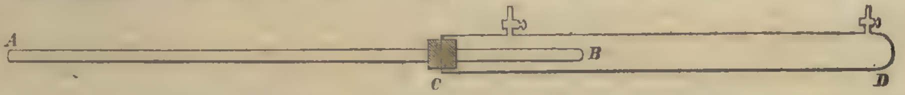
It was found that the separation of the two plates can be accomplished by any force, however small, only the time in which the distance of the plates is increased by a certain fraction through the action of such a force, is all the greater, the smaller this force is. This time is still greater if the two plates are in water or in another liquid, instead of in air. To give an idea of this we may mention that the distance of two plates, of 155 millimetres diameter, under water, which originally was 0·1 mm., was increased in consequence of the continuous pull of 1 gramme by 0·01 mm. only in 1½ minutes, by 0·1 mm. only in 7 minutes.

Herr Stefan in his experiments measured the time that passed while the original distance of the plates increased by a certain fraction. First, the law was established for the motion of the plates in liquids as well as in air, that the times stand in the reverse proportion to the separating force. With the same overweight they are the longer, the smaller the original distance of the plates, but this in a far greater than a simple proportion; they increase nearly in square proportion if the distance of plates decreases in a simple one. For different sized plates the times in question stand in the proportion of the fourth powers of the semi-diameters of the plates; for different liquids in the same proportions as the times which elapse, while equal volumes of these liquids flow through a capillary tube, under equal pressure.

It results clearly that with this phenomenon there rests a problem of hydrodynamics and not of molecular forces. The phenomenon can be explained in the following manner:—When the separating force begins to act, the distance of the plates is increased by an infinitely small part. The space contained between the plates is thus enlarged, the liquid therein contained is dilated, and consequently its hydrostatic pressure decreased. The over-pressure of the exterior liquid acts against the separating force. No equilibrium is, however, attained, because the decrease of hydrostatic pressure between the plates causes an inflow of the exterior liquid and thus a decrease of the difference of pressure. The distance of plates may be again increased by the separating force, and then the same process is repeated in a continuous manner.

Herr Stefan has therefore given the name of *apparent adhesion* to this phenomenon. He has tried to deduce theoretically all the different laws to which the different experiments have led him; he has succeeded in finding an equation which expresses these laws, and which at the same time permits the deduction of the co-efficients of interior friction of the liquids experimented with, directly from the experiments. The values of the coefficients obtained in this manner correspond almost exactly with those obtained by the experiments of Poisseville, Maxwell, and O. E. Meyer. But as Herr Stefan thinks the theoretical solution of the problem only an approximate one, we reserve further details on the subject.

If we rub a wet cloth quickly over a glass tube, closed at both ends, it is caused to vibrate longitudinally. If at the same time it gives its lowest longitudinal note (as we will suppose for the sake of simplicity), then the end planes of the tube strike quite periodically against the air enclosed in it, and cause the same to vibrate. These vibrations are isochronous with those of the tube itself. They proceed from both ends of the tube towards one another, and, as a consequence, standing waves are formed in the enclosed air column. If into such a tube lycopodium or silicic acid has been placed, these powders (as also Herr Kundt has discovered a few years ago) collect at the node points of the standing waves and form figures of a very peculiar kind. As the length of these standing waves depends solely on the height of the generating sound and of the velocity of the waves in the gas, with which the tube is filled, the proportion of this wave-length to the wave-length in the glass gives the relative velocity of sound in air, with that in the glass as unity. Herren Kundt and Lehmann at Strasburg have lately tried to produce longitudinal vibrations and the figures just mentioned in a liquid, enclosed in a cylindrical tube, in a similar manner. It was found that in a column of water standing waves and figures can be produced almost as easily as in a column of air. The apparatus which was used for this purpose consisted of a glass tube, A B, closed at one end, B, which was placed firmly into a wider glass tube, C D, by means of an india-rubber stopper. The latter glass tube was closed at end D, and had two lateral outlets with stopcocks, so as to be easily filled with water. The powder which is placed in the tube C D must be sufficiently heavy and of a certain degree of fineness; it is best to use for this purpose finely divided iron (*Ferrum limatum*). The column of liquid must be free of even the smallest air-bubble. If the liquid used, for instance water, contains a gas absorbed, it must be first freed from it by continual boiling. In order to make the apparatus sound it is necessary only to rub a wet cloth quickly over the protruding part of the tube A B.



The figures in this column of liquid may serve for the determination of the velocity of sound in the liquid. If the end A of the sounding tube is closed by a cork, and if then over this end another tube is attached, which contains lycopodium, then, by the figures which occur in the liquid, and by those which occur in the tube with air, the wave-length of the same sound is obtained both in liquid and in air. The proportion of both gives the relative velocity of sound in the liquid with reference to that in air as unity. This relative velocity multiplied by the absolute velocity in air at the same temperature, gives the absolute velocity of sound in the liquid at the temperature in question. It was interesting to compare the results of this method of determining the velocity of sound in water, with the values required by the ordinary theory of the velocity of sound. According to the theory based on the experimentally determined elasticity of water, the velocity of sound at 8° Celsius is 1,437 metres. Colladon and Sturm, by their experiments in the Lake of Geneva, found the same to be 1,435 metres at 8° C. Although the remarkable coincidence of these values is only accidental, it is nevertheless proved that experiments such as those of Colladon and Sturm do not give figures that are very far from the theoretical values. The experiments of Kundt and Lehmann show that the diameter and thickness of the glass of the tube, which is used for the determination of the velocity of sound according to the method above described, greatly affect the value of the velocity of sound in water. In a tube of 2·2 mm. thickness of side, and 28·7 mm. diameter, the velocity at 18° C. was 1040·4 metres (the mean of two experiments which coincided very closely); in another one of 5 mm. thickness of side and 14 mm. diameter, the velocity was found 1382·2 metres at 22·2° C. As it would be very difficult to avoid unevenness in the sides of the tube, it does not seem probable that when using tubes the above value of 1,435 metres could be completely reached. These experiments, proving the influence of the thickness of the sides and diameter of a tube upon the velocity of sound in water, contradict the hypothesis of Wertheim, according to which a column of liquid, which is sounding or conducting sound, behaves like a firm rod. S.W.

MAGNETO-ELECTRIC MACHINES*

FEW discoveries in physical science have been more important in themselves, or richer in practical results, than Faraday's discovery of the induction of electrical currents; and with the exception of the immortal work of Newton on the properties of Light, it would be difficult to mention any other experimental investigation, as it first issued from the hands of the author, so complete in all its details, or so full of new and original facts. Œrsted's grand discovery, which linked together electricity and magnetism, had already yielded a scientific harvest of uncommon richness. It led immediately to the construction of electro-magnets vastly exceeding in power any permanent magnets which were then known or have since been made. The multiplier or galvanometer of Schweigger supplied a new and important instrument for measuring electrical currents, which, with a little modification, became the electric telegraph. Faraday discovered the rotatory character of the reciprocal action of magnets and electrical currents; and Ampère showed that all the properties of a permanent magnet could be explained on the hypothesis of electrical currents in a fixed direction circulating around the magnet. A problem which proved to be one of surpassing difficulty, and long baffled many of the most distinguished physicists of Europe—to obtain electrical currents by means of a steel magnet—was in 1831 completely solved in the exhaustive memoir by Faraday, in which he announced the discovery of the induction of electrical currents. It may be interesting to describe, nearly in his own words, Faraday's original experiments.

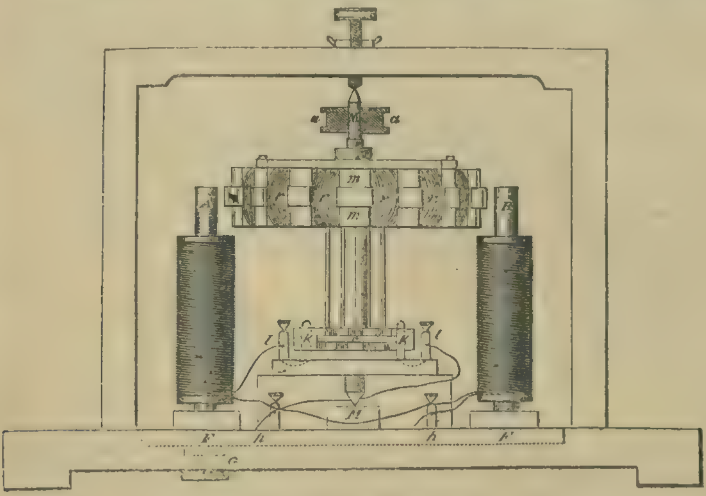


FIG. 1.—Pacinotti's Machine.

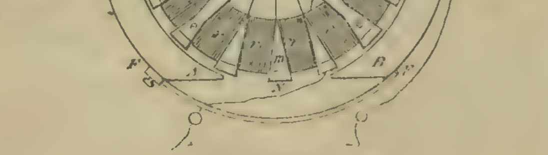


FIG. 2.—Pacinotti's Machine (Plan).

Two helices of insulated copper wire were passed round a wooden block, the ends of the wire of one helix being connected with a voltaic battery, and those of the other with a galvanometer. So long as the current from the battery passed through the first helix the needle of the galvanometer remained motionless, but on breaking the connection with the battery, a momentary current, as indicated by the galvanometer, traversed the wire of the second helix. The direction of this current was the same as that of the primary current of the battery. When the first helix was connected with the battery, another momentary current traversed the second helix, but in this case it was in the opposite direction to the primary current. Substituting for the first helix and the voltaic battery a permanent steel magnet or an electro-magnet, Faraday found that on introducing one end of the magnet into a hollow helix a temporary current was produced in the wire of the helix in one direction, and on withdrawing it another temporary current occurred in the opposite direction. For artificial magnets the magnetism of the earth may be substituted, and thus electrical currents can be obtained by induction from the magnetic conditions which everywhere prevail on the surface of this globe. The singular phenomenon first described by Arago, and afterwards elaborately investigated by Babbage and Herschel, that when a copper plate is rotated below a freely suspended magnet the latter tends to follow the motion of the plate, was shown by Faraday to arise from electrical currents induced by the magnet in the rotating metallic disc.

Soon after the announcement of these important results, Pixii constructed in Paris the first magneto-electric machine. I have still a vivid recollection of this machine as I saw it in Pixii's workshop. The currents were obtained by the rotation of a powerful horse-shoe magnet in front of an armature composed of two short bars of soft iron with a connecting crossbar, the latter being surrounded by a long coil of copper wire covered with silk. The armature had, in short, nearly the form of a horse-shoe electro-magnet. With this machine electrical sparks were obtained, and water was freely decomposed. In the rotation of the magnet the faces of the armature or electro-magnet became successively north and south poles with intermediate conditions of neutrality, and the direction of the current changed at every semi-revolution of the magnet. Hence, in the decomposition of water and other electrolytes, the ele-

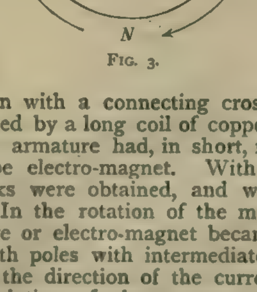


FIG. 3.

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* The substance of a Lecture, with additions, delivered at the Belfast Philosophical Society, March 17, by Dr. Andrews, F.R.S., L. & E.

ments or radicles produced by the electrolysis could not be obtained separately. Pixii is said to have applied a commutator to his machine in order to obviate this defect. An important modification of Pixii's machine was soon after made by Paxton, who caused the armature to revolve instead of the permanent magnet. According to the character of the current required, armatures with longer or shorter wires were employed. A large machine of this construction, exhibited some years ago at the Polytechnic Institution in London, was capable of igniting a short platinum wire. In Clarke's machine the position of the armature was altered and an improved commutator applied. Siemens afterwards, by giving the armature a cylindrical form, rendered it more compact and better fitted for rapid rotation.

Siemens' armature was happily applied by Wilde, in 1866, to the construction of a machine of extraordinary power. Starting from a small magneto-electric machine provided with six steel magnets, each weighing one pound, and capable of carrying about ten times their weight, Wilde transmitted the direct current from this machine through the coils of an electro-magnet provided like the former with a Siemens' armature, and the direct current from the latter he in like manner transmitted through the coils of another large electro-magnet—so large, indeed, that its armature alone weighed above one third of a ton. This was also provided with a Siemens' armature. When the machine was in full action it melted a rod of iron 15 inches in length and a quarter of an inch in diameter, and gave the most brilliant illuminating effects when the discharge took place between carbon points. As nearly as could be estimated, the mechanical force absorbed in producing these results was from eight to ten-horse power. Wilde's machines have been successfully employed by Messrs. Elkington for the precipitation of copper and other metals, and he has lately proposed some important modifications to adapt them to the production of the electric light.

Some years before Wilde's experiments were published, Holmes had constructed on the Saxton principle a powerful magneto-electric machine, which has been successfully used at Dungeness and other lighthouses, and machines differing little from Holmes's are employed in some of the French lighthouses. In Holmes's original machine forty-eight pairs of compound bar-magnets were arranged for the armatures (160 in number) to revolve between the poles of the magnets, and by a system of commutators the current was obtained always in the same direction. Its amount, however, varied at almost indefinitely short intervals from a maximum to one-half of that amount. In practice these variations were wholly inappreciable.

The first suggestion of a magneto-electric machine capable of giving a continuous current always in the same direction is due to Dr. A. Pacinotti, of Florence. In the nineteenth volume of "Il Nuovo Cimento," which was published in 1865,* Pacinotti describes the model of an electro-magnetic machine constructed, some time before, under his direction, for the Cabinet of Technological Physics in the University of Pisa, whose essential feature was a novel form of armature to which he gave the name of "transversal electro-magnet." This armature was formed of a toothed iron ring, *m m* (Fig. 1), capable of rotating on a vertical axis, M M, and having the spaces between the teeth occupied by helices of copper wire covered with silk. The wire of the helices was always wound in the same direction round the ring, and the terminal end of each helix was brought into metallic connection with the adjoining end of the wire of the succeeding helix. From these junctions connecting wires were carried down parallel to the axis of the machine, and united to insulated plates of brass, of which a double row, as shown in Fig. 1, were inserted in a wooden cylinder, *c*, which was itself firmly attached to the lower part of the axis. The current entered through the successive brass plates as they came into contact with a small metallic roller, *k*, which was in communication with one pole of a voltaic battery. At the point of junction with the wires of the helices, the current from the battery divided into two parts, which respectively traversed in opposite directions the connected helices, each through a semi-diameter of the ring, and finally left the machine on the opposite side by a second roller, *k*, which was in connection with the other pole of the battery. When the connections were made, the iron ring began to rotate round its axis with considerable force. In a trial in which the current was supplied by four small elements of Bunsen, a weight of several kilogrammes was raised. In the apparatus as actually constructed, the poles of the electro-magnet were enlarged by the addition of two segments of soft iron, A A, B B (Fig. 2), which extended over the greater part of the iron ring. The details of the construction of the transversal electro-magnet will be easily understood from the plan given in Fig. 2.

Towards the end of the paper to which I have already referred, Pacinotti shows that the iron ring armature, or transversal electro-magnet, may be applied to reverse the conditions just described, and to obtain continuous electrical currents, always in the same direction, from a magnet, whether a permanent one, or an electro-magnet. As the original paper has not, as far as I know, been translated into English, and the scientific journal in which it was published is little known in this country, I will not make any apology for giving the following extract without abridgment.

"If we substitute for the electro-magnet A B (Fig. 1) a permanent magnet, and make the transversal electro-magnet revolve, we shall have a magneto-electric machine which will give an induced continuous current always in the same direction. To find the most suitable positions on the commutator from which to collect the induced current, let us observe that in presence of the poles of the fixed magnet, there are formed, by influence, at the extremities of a diameter, opposite poles on the moveable electro-magnet. These poles, N S (Fig. 2), maintain a fixed position when the transversal electro-magnet rotates upon its axis; and therefore, in respect to the magnetism and consequently to the induced currents, we may consider, or suppose, that the helices of copper wire move round on the ring magnet while the ring itself remains at rest. To study the induced currents which are developed in these helices, let us take one of them in the various positions it can assume. From the pole N (Fig. 3) advancing towards the pole S, there will be developed a direct current in one direction till the middle point *a* is reached; on passing this point the current will assume an opposite direction. Proceeding from S towards N, the current will maintain the same direction which it had from *a* to S, till the middle point *b* is reached; after passing *b* the direction will be again changed, and will now be the same which it had from N to *a*. Now, since all the helices communicate with one another, the electro-motive forces will be collected in one given direction, and will give to the entire current the course indicated by the arrows in Fig. 3;* and for collecting it, the most suitable positions will be *a b*; that is to say, the rollers on the commutator should be placed at right angles with the line of magnetism of the electro-magnet."

Pacinotti does not appear to have constructed specially a magneto-electric machine on the above principle, but he states that he verified the correctness of his views by turning the iron ring in the electro-magnetic machine, and observing the direction of the currents when a galvanometer was introduced into the circuit.

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* The date on the title-page of the volume is 1863, but it contains a letter dated Rome, Jan 19, 1865

* Fig. 3, as given in the text, is an exact fac-simile of the corresponding figure in the original. It is obvious from the figure itself, as well as from the text, that there is an error in the engraving, and that the arrow between S and *b* should point towards S and not towards *b*.

The results he obtained were not great, but were sufficient to enable him to announce that a magneto-electric machine could be constructed which would have the advantage of giving the induced currents all in the same direction, without the help of mechanical arrangements to separate opposed currents or to make them conspire with one another.

From the foregoing analysis of Pacinotti's memoir, there can be no doubt that it contains a description of the ring armature which in the hands of Gramme has recently led to the construction of magneto-electric machines giving continuous currents of great intensity. I cannot, however, pass over without notice an extraordinary blunder into which Pacinotti has fallen, and which would render any machine constructed after his model altogether valueless. By a reference to Fig. 2, which, as well as Figs. 1 and 3, has been engraved from a photograph of the plate appended to the original memoir, it will be seen that the letters N and S are placed at the end of the diameter of the ring which is at right angles to the line A B joining the poles of the fixed magnet. That Pacinotti intended these letters to designate north and south magnetic poles is manifest from the following passage among others in his memoir:—"Osserviamo che per influenza sulla elettro-calamita mobile si formano i poli opposti alle estremità di un diametro in presenza ai poli della calamita fissa. *Questi poli* N S mantengono una posizione fissa anche quando la elettro-calamita trasversale ruota sul suo asse." It is hardly necessary to say that the positions assigned by Pacinotti for the poles in an iron ring under the influence of a fixed magnet are in reality those of the neutral points, or points of no magnetism, and that the magnetic poles of the ring are at a distance of 90° from the positions stated by him. This mistake has led to a serious blunder in the construction of his machine, the metallic rollers which carry off the induced currents being placed, not at the neutral points (as Pacinotti has himself clearly showed that they ought to be), but at the poles of the ring. That any effects at all were obtained from the model at Pisa, we must attribute to the slight shifting of the poles of the ring due to its rotation. Apart, however, from this unaccountable error, it can scarcely be disputed that to Pacinotti is due the merit not only of having devised the ring armature or transversal electro-magnet, but of having also accurately analysed its mode of action.

(*To be continued.*)

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*LECTURES AT THE ZOOLOGICAL GARDENS**

V.

Mr. Garrod on Camels and Llamas

THE Tylopoda form a group which includes the Camels together with the Llamas; the name indicating that their feet are covered with callous skin instead of with hoofs as in the typical Ruminants, from which group they also differ considerably in many other characters, to be considered seriatim.

Horns are not developed in either sex. The upper lip is hairy and partly cleft. False hoofs are wanting. The general body-proportions are not so symmetrical as in any of the Cavicornia or Deer. Osteologically several special features present themselves. In the vertebræ of the neck the canals which are developed in the transverse processes, for the vertebral arteries to run in on their way to the brain, are excavated in the sides of the spinal canal of the cervical region. In the ankle two of the bones—the naviculare, or scaphoid, and the cuboid—which are anchylosed in the true Ruminants, are independent of one another. In the upper jaw there are two teeth developed, one on the side of each premaxilla; they are therefore lateral incisors. The canines in the lower jaw are of a different shape, and are separated by an interval from the incisors. The molars form a series of five above and four below; in the Camels, but not in the Llamas, an additional small premolar, isolated in position and following the canine, is to be found in both jaws, increasing the grinder series to six above and five below on each side.

The abnormal conformation of the gastric section of the alimentary canal in the Camels has attracted the attention of many naturalists. In the Llamas the same structure maintains. As in the typical Ruminants the stomach is composed of several cavities communicating one with the other, but there is some difficulty in deciding which are the exact homologues of the *rumen*, *reticulum*, *psalterium*, and *abomasum*. The first cavity is a capacious globose sac into which the œsophagus opens. A longitudinal band of muscular fibre partly constricts it, in its course from the right side of the cardiac orifice backwards along the ventral surface, opposite the middle of which a narrow and long aggregation of "water cells" starts to continue tranversely towards the left side of the organ. This longitudinal muscular band forms one of the boundaries—the left one—of a much larger collection of deeper water cells, which embrace the posterior portion of the right side of the paunch in the concavity of their crescentic mass. From the right of this first main compartment a second smaller one is cut off by a constriction which leaves a considerable opening between the two. Its position is that of the reticulum; it is deeply honeycombed, the lining membrane of the cells being covered with villi much like those on the surface of the folds of the psalterium of the deer, &c. The cell-walls are thin and but slightly muscular. In the paunch the mucous membrane is smooth and not at all thick. The water-cells are formed on a framework of many intersecting muscular sheets arranged in layers with intervals of less than an inch between them, one half being at right angles to the other, so as to form rows of quadrilateral cavities. These are again incompletely divided up by secondary septa. The orifices of the cells are partly closed by diaphragm-like membranes at their mouths. Most probably the contraction of the aggregated muscular fibres in the same situations is capable of closing the cells completely when necessary. That the camel can store fluid in these water-cells is borne out by the experience of so many authors that doubt is scarcely possible. For instance, in his "Travels to discover the Source of the Nile," Bruce (vol. iv. p. 596) tells us on one occasion that "finding the camels would not rise, we killed two of them . . . and from the stomach of each got about four gallons of water, which the Bischareen Arab managed with great dexterity." As John Hunter remarks, there is no physiological reason why this should not be the case. A specialised structure is observed by zoologists; a special power is attributed by travellers; the function and the structure may be reasonably correlated: why should they not be so, as no other explanation suggests itself? There is no arrangement for closing the cells of the reticulum similar to that found in those of the rumen.

A muscular fold runs from the termination of the œsophagus along the superior or vertebral side of the lesser curvature of the stomach to the third compartment, which evidently directs the products of rumination into it, just as the two folds of the same region do which traverse the reticulum in the typical Peccora. Following the honeycomb-bag is a single elongate cylindrical cavity, which dilates slightly and becomes bent at its pyloric extremity. This compartment is thin-walled and longitudinally ribbed internally for its proximal five-sixths, beyond which the mucous membrane is much thickened and evidently digestive in character, especially in the neighbourhood of the angle of the inflection in that region. This section of the stomach apparently corresponds to the abomasum, the psalterium being absent. In the Bactrian Camel there is a partial constriction in it, which separates off a small proximal cavity, which may be its homologue.

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* Continued from p. 69.

In the corpuscles of the blood the Tylopoda are unique among Mammalia, these minute discs being oval instead of, as in all other members of the class, circular.

Of the Camels there are two species, both domesticated, the Bactrian and the Arabian; the one possessing two humps and the other one. A swift variety of the latter is called the Dromedary. The former inhabits Turkestan, Persia, Thibet, and Mongolia; the latter Arabia and Northern Africa. Of the Llamas there are two wild species which have each of them domesticated representatives; the feral Guanaco and Vicuna finding their tame representatives in the Llama and Alpaca. They are all found in the Cordilleras of the Andes, down as far as Terra del Fuego. Taking the Tylopoda as a whole, their geographic range is extremely exceptional. Closely allied animals, as the Ostrich and the Rhea, are found in South Africa and South America respectively. North Africa and Arabia, in some respects, resemble India, as far as their fauna is concerned. No similar ties bind Northern Africa with South America, and it is this which makes the distribution of the Camels and Llamas so abnormal and so inexplicable, on the assumption that they sprang from a common ancestor as far back as the Miocene age, when we take as our basis the assumption that the existing zoological regions are the remains of a very different distribution of land.

(*To be continued.*)

THE LINE BETWEEN HIGHLANDS AND LOWLANDS

THE usual ten days' excursion which terminates the work of the Geological Class at the University of Edinburgh, has this year been devoted to an experiment in the practical teaching of Geology which bids fair to be often and profitably repeated—viz., the working out of a definite problem in the field, teacher and students together. In the Class excursion to Arran in 1872, it was observed that the Old Red Sandstone appeared to be brought against the Highland schists by a fault. Last year the fault was actually seen by the Class on the other side of the island in the cliffs of Stonehaven. Accordingly, the task proposed to be accomplished this year was to trace this dislocation across the country, if possible, from sea to sea. Such a traverse would at least bring the pedestrians face to face with some of the finest and least visited river scenery in Scotland, while it would probably also impress some geological lessons on their memory in a way not likely ever to be forgotten. At the same time it might be successful in discovering some new points in British geology.

The party mustered at Edinburgh, and proceeded at once to Stonehaven, where the first day's work consisted in following the magnificent coast-section which rises above the sea in the picturesque cliffs of Kincardineshire. The fault by which the slates and greywackes of the Highlands have been brought side by side with the red sandstones and shales of the Lowlands was again found. The rocks have there been so greatly squeezed against each other that their line of separation is by no means so abrupt as it might be expected to be. Instead of the mass of débris which so often fills up the space between the cheeks of a large dislocation, there was in this case a somewhat tortuous line of junction along which, without any broken materials intervening, the two series of Highland and Lowland rocks seemed to be, as it were, welded together. One might pass this part of the section and fail to notice the fault, though at the distance of a few yards he would find himself in a totally different set of rocks, and would then turn back to discover the actual line of separation. That this fault must be an important one was first shown by the fact that the strata of the Old Red Sandstone have here been thrown on end for more than two miles back from their junction with the Highland rocks. Along the noble coast cliffs the beds of sandstone and conglomerate stand on edge like books on the shelves of a library. The portion of them so placed considerably exceeds 10,000 feet in thickness, and yet by no means includes all the Old Red Sandstone of this part of Scotland.

From Stonehaven the party worked its way across the country for more than 100 miles to the Aberfoyle district. The line of junction between the slates and the Old Red Conglomerates and Sandstones was traced at many points, and sometimes followed for miles across the moors. In no case was the actual fault again seen, but its position could be in most cases drawn firmly on the map by help of the numerous sections laid open by the rivers which descend from the south-eastern slopes of the Grampians. As the journey advanced, however, it was discovered that the fault did not always lie between the Highland rocks and the Old Red Sandstone, but that it sometimes left bays of the latter formation on its north side. This was a new and interesting fact, for it showed the base of the Old Red Sandstone of these regions lying undisturbed and unconformably upon the upturned edges of the slates. In these bays were found enormous beds of coarse volcanic conglomerate and sheets of porphyrite, precisely agreeing with those which form the chains of the Ochil and Sidlaw Hills on the south side of the great valley which here flanks the Highlands. It was, therefore, apparent that the lavas, ashes, and gravels originally extended quite up to and enveloped the base of the Highland mountains that bounded on the north the inland sea or lake in which the Old Red Sandstone was deposited.

But perhaps the question of most general interest elucidated by this excursion was the relation between lines of dislocation and lines of valley. The fault which begins on the east coast at Stonehaven and runs in a straight line across the country to Arran—a distance of 170 miles—is probably one of the greatest, if indeed it is not absolutely the greatest, in Britain. We do not yet know the amount of displacement which it has caused. But that it was accompanied by enormous movement of the earth's crust is sufficiently proved by the band of vertical strata, sometimes more than two miles broad, which runs along its southern border. Surely if the valleys and gorges of this country, as many writers still contend, have been caused by or are coincident with lines of subterranean fracture, such a grand line of fracture as this ought to be strikingly characterised by such surface features. Particular attention was devoted to this point during the excursion, and the result may be briefly given. Not a single main valley was found to run along the fault, while all the valleys and some of the deep gorges emerging from the Highlands run directly across it without deflection. In one case only was there an approach to a coincidence between the line of the fault and a glen, viz., in that of Glen Artney. But there the dislocation, instead of keeping the centre of the valley, was found to run far up on the northern side, the stream in the centre winding to and fro across the vertical strata of Old Red Sandstone. Along its whole course the fault is not more marked than on other lines where two series of rocks of different characters and modes of weathering come together. But not only does no long and broad valley or series of valleys mark the line of this fracture in its passage across the island; it passes athwart the channels of the North and South Esk, the Prosen, the Isla, the Ericht, the Tay, and the Forth, without in the least degree producing any waterfalls or transverse gorges. Moreover, it cuts across two of the best known lakes of the Southern Highlands, Lochs Vennachar and Lomond, without revealing its presence by any abrupt surface features. These transverse valleys can be admirably studied in some of the river ravines. The gorges of the Ericht, Isla, and North Esk, indeed, are true cañons, their precipitous walls range from 80 to sometimes 200 feet in height, between which the rivers toil in narrow tortuous chasms. It is easy to examine the strata in these natural sections, and to find conclusive proof that in spite of their fissure-like character the ravines have been cut out of the solid and unbroken Old Red Sandstone, the strata of which can be traced from side to side in undisturbed continuity. The pot-holes marking old levels of water-grinding can be traced at various heights above the present streams, which are still at work deepening their channels in the same way. The contribution therefore which this geological ramble makes to the discussion of an interesting question in the physiography of Great Britain may be put thus:—An enormous dislocation crosses the island along the southern margin of the Highlands. It has not given rise to any marked line of glens or valleys. It is crossed by all the rivers and some of the lakes which emerge from the southern side of the Grampians, and some of these rivers flow in deep narrow gorges across the line of fracture. Yet in none of these gorges could any trace be found of transverse fracture; on the contrary, they everywhere bore evidence only of long-continued aqueous erosion.

Another point of interest noted in the course of the excursion was the fact that Comrie—a locality so long and widely celebrated for its frequent and sometimes sharp earthquake shocks—lies almost directly over the line of the great fault. This fact seems to be the first of any consequence which has been ascertained in the attempt to connect the abundance of tremors at that place with any geological structure of the ground underneath. From this brief notice it will be seen that there was plenty of geological interest and novelty to keep up the enthusiasm of the party from the beginning to the close of the excursion. Glorious weather and an endless variety of scenery added fresh charms to each day's work, while over the whole came the glee and hearty exuberance which the free open face of nature could not but evoke in men who had been working hard together in town all the winter and spring.

THE U.S. GOVERNMENT BOARD FOR TESTING IRON AND STEEL

IN accordance with "An Act making Appropriations for Sundry Civil Expenses of the Government, for the fiscal year ending June 30, 1876, and for other purposes," approved March 3, 1875, and in reply to a memorial presented to Congress in January last by the American Society of Civil Engineers, the President of the United States has appointed a Board with instructions to determine by actual tests the strength and value of all kinds of iron, steel, and other metals which may be submitted to or procured by it, and to prepare tables which will exhibit the strength and value of these materials for constructive purposes.

The object of this Board is so admirable, and in this, as already in some other similar respects, the U.S. has set an example so worthy of imitation by European Governments, that we shall be doing a service in publishing the details of the organisation of the Board. Congress, we may state, has voted 50,000 dollars to defray the expenses of the Board.

The following are the names of its members:—President, Lieut.-Col. T. T. S. Laidley, U.S.A.; Commander L. A. Beardslee, U.S.N.; Lieut.-Col. Q. A. Gillmore, U.S.A.; Chief Engineer David Smith, U.S.N.; W. Sooy Smith, C.E.; A. L. Holley, C.E.; R. H. Thurston, C.E., Secretary.

The work of the Board is divided into sections, each section being entrusted to a standing committee from the members of the Board. The following are the Sections:—

(A) *On Abrasion and Wear.*—Instructions: To examine and report upon the abrasion and wear of railway wheels, axles, rails, and other materials, under the conditions of actual use.

(B) *On Armour Plate.*—Instructions: To make tests of armour plate, and to collect data derived from experiments already made to determine the characteristics of metal suitable for such use.

(C) *On Chemical Research.*—Instructions: To plan and conduct investigations of the mutual relations of the chemical and mechanical properties of metals.

(D) *On Chains and Wire Ropes.*—Instructions: To determine the character of iron best adapted for chain cables, the best form and proportions of link, and the qualities of metal used in the manufacture of iron and steel wire rope.

(E) *On Corrosion of Metals.*—Instructions: To investigate the subject of the corrosion of metals under the conditions of actual use.

(F) *On the Effects of Temperature.*—Instructions: To investigate the effects of variations of temperature upon the strength and other qualities of iron, steel, and other metals.

(G) *On Girders and Columns.*—Instructions: To arrange and conduct experiments to determine the laws of resistance of beams, girders, and columns to change of form and to fracture.

(H) *On Iron, Malleable.*—Instructions: To examine and report upon the mechanical and physical proportions of wrought iron.

(I) *On Iron, Cast.*—Instructions: To consider and report upon the mechanical and physical properties of cast iron.

(J) *On Metallic Alloys.*—Instructions: To assume charge of a series of experiments on the characteristics of alloys, and an investigation of the laws of combination.

(K) *On Orthogonal Simultaneous Strains.*—Instructions: To plan and conduct a series of experiments on simultaneous orthogonal strains, with a view to the determination of laws.

(L) *On Physical Phenomena.*—Instructions: To make a special investigation of the physical phenomena accompanying the distortion and rupture of materials.

(M) *On Re-heating and Re-rolling.*—Instructions: To observe and to experiment upon the effects of reheating, re-rolling, or otherwise re-working; of hammering, as compared with rolling, and of annealing the metals.

(N) *On Steels produced by Modern Processes.*—Instructions: To investigate the constitution and characteristics of steels made by the Bessemer, open hearth, and other modern methods.

(O) *On Steels for Tools.*—Instructions: To determine the constitution and characteristics, and the special adaptations of steels used for tools.

The Sectional Committees of the Board, we learn from the official circular sent us, are appointed to conduct the several investigations, and the special researches assigned them in the interval during which the regular work of the Board is delayed by the preparation of the necessary testing machinery, and during such periods of leisure as may afterward occur.

These investigations are expected to be made with critical and scientific accuracy, and will, therefore, consist in the minute analysis of a somewhat limited number of specimens and the precise determination of mechanical and physical properties, with a view to the detection and enunciation of the laws connecting them with the phenomena of resistance to flexure, distortion, and rupture.

The Board will be prepared to enter upon a more general investigation, testing such specimens as may be forwarded to the President of the Board, or such as it may be determined to purchase in open market, immediately upon the completion of the apparatus ordered, at which time circulars will be published giving detailed instructions relative to the preparation of specimens for test, and stating minutely the information which will be demanded previous to their acceptance.

GUSTAVE THURET

ON the 10th of May France lost one of her most distinguished naturalists. M. Thuret left his home at Antibes in perfect health, and expired at Nice a few hours afterwards from an attack of angina pectoris.

Unlike many of his contemporaries, Thuret was not a voluminous writer. But his papers, though not numerous, are all extremely admirable, and his work has laid the foundation of our modern knowledge of the biological phenomena of the Algæ. Probably his earliest paper was an account of the antherozoids of *Chara* (1840). He was the first to detect the cilia upon these structures in any plant. In 1844 he published an account of the peculiar mode of asexual reproduction in *Nostoc*. In 1845, in conjunction with Decaisne, he described for the first time the antheridia and antherozoids of *Fucus*. In 1850 and succeeding years he published his admirable papers upon the zoospores of different groups of Algæ. In 1853 he established for the first time by actual observation, in the case of *Fucus*, the existence amongst Algæ of the phenomenon of fertilisation. In 1866, in conjunction with Bornet, he described the extremely remarkable phenomena of sexual reproduction amongst the *Florideæ*. They found not merely that the process of fertilisation was accomplished in a very peculiar and remote way, but also that, besides the effect produced on the germ-cell, a series of developments were induced in the parent plant as the result of it. In every group of Algæ the results which he achieved were of the most fundamental kind.

A man of independent wealth, he passed a great part of the year on his property at Antibes, on the shore of the Mediterranean. Bornet, his distinguished *collaborateur*, lived with him. In the gardens which surrounded his house he had assembled one of the most remarkable collections of plants to be found growing in the open air in any part of the world. W. T. T. D.

NOTES

PUNCTUALLY at the time arranged, four o'clock in the afternoon of last Saturday, the *Alert* and the *Discovery*, accompanied by the *Valorous*, left Portsmouth for their work in the Arctic regions. No better equipped expedition, it may again be said, has ever left any country, and no previous British expedition has ever been so universally popular. Every available point on land was occupied by spectators who had come to see the departure of the expedition. The vessels in the harbour and the yachts and boats along the beach were dressed with flags, and as the two ships stood out to sea their course lay through a perfect flotilla of craft of all kinds, whose occupants cheered Capt. Nares and his companions on their way. Among the last messages received by Capt. Nares was a telegram from the Queen "wishing you and your gallant companions every success;" the telegram was accompanied by a packet, the contents of which did not transpire. In the morning the Lords of the Admiralty inspected the ships, and wished the expedition "God speed." Mr. Clements R. Markham accompanies his cousin, Commander Markham, as far as Disco. The ships arrived at Queenstown on Tuesday, the *Alert* and *Discovery* going on to Bantry Bay. The *Valorous* joined them yesterday, when the three proceeded on their way.

MR. GEORGE BENTHAM, F.R.S., has been elected a corresponding member of the French Academy of Sciences.

MR. CHARLES DARWIN has been appointed foreign honorary member of the Imperial Academy of Science, Vienna.

THE Hebdomadal Council of Oxford University have agreed to propose that in the Convocation to be held at the Encœnia, or Commemoration, the honorary degree of D.C.L. be conferred on the following persons:—Sir W. R. Grove, F.R.S., Sir J. Lubbock, F.R.S., Mr. E. B. Tylor, F.R.S., Captain Douglas Galton, C.E., F.R.S., and Mr. C. T. Newton.

THE reception at the Royal Society on Wednesday week was a great success; there was a very large attendance of Fellows. There was plenty of opportunity for quiet talk, which was taken ample advantage of. Mr. Crookes repeated his interesting experiments.

GOVERNMENT have refused to send or pay the expenses of a commissioner to the forthcoming International Geographical Congress at Paris. One would have thought that, as much from a practically commercial as from a scientific point of view, this Congress, judging from its programme, is likely to be of the highest importance; and who more likely to reap benefit from such a Conference than the greatest naval and commercial power in the world? Government, however, have the excuse that the French Government simply approve of the Congress, and have refrained from stamping it with an official character.

INVITATION circulars have been issued for the Bristol Meeting by the British Association, whose sittings commence on August 25, under the presidency of Sir John Hawkshaw, C.E., F.R.S. The local secretaries are Messrs. W. Lant Carpenter and John H. Clarke.

M. EDOUARD COLLOMB, who for many years has been the Treasurer of the Geological Society of Paris, has just passed away at the age of seventy-four years. M. Collomb accompanied Agassiz in his Alpine travels. He also travelled during many years in Spain with M. de Verneuil, studying the mineralogical resources of the Iberian Peninsula. The result of these protracted explorations was the publication of the first geological map of Spain.

MR. HENRY WILLETT again appeals for funds to carry on the work of the Sub-Wealden Exploration to a depth of 2,000 feet. A week ago the boring had reached 1,080 feet. It has been decided to continue the boring to 1,500 feet, by which time all the available funds will be exhausted; to do this, 1,200*l.* are wanted, and we cannot think that for the want of so comparatively small a sum the first scientific boring in this country will be brought to a premature conclusion. The latest cones and fossils indicate that the boring is still in the Kimmeridge Clay, to the fauna of which *Ammonites Jason* must now be added.

THE acclimatisation of trout in Tasmania is certified by an official report, which states that in 1873 a total distribution of 4050 trout ova was made from the rivers of that country to the neighbouring colonies; 800 of these ova were sea trout, and the rest brown trout.

THE motion for diminishing the size of the type used in printing the *Comptes Rendus* was lost, because a number of members declared in the private sitting of the Academy that it was impossible for them to read the papers printed with the characters which had been proposed. Consequently it has been resolved that the number of pages given to each paper shall be diminished by one-third part of the number originally allotted.

THE Municipal Council of Paris have voted a sum of 500*l.* to pay the professors of a superior school of Anthropology, which will be opened next November in a building lent gratuitously by the École de Médecine; no fees are to be charged from pupils. M. Wallon has granted a sum of 300*l.* yearly for laboratory expenses. Anthropological societies and private individuals have subscribed a fund; the shares are said to be worth 40*l.* Five courses of lectures are to be delivered, including a series by M. Broca on Craniology, by M. Dailly on Human Races, M. G. de Mortillet on Prehistoric Times. The number of lectures is to be increased as the resources of the association multiply.

ACTIVE preparations are being made for the exhibition of the French Geographical Society at the Pavillon des Flores. The large hall is almost finished, and is said to be of superior taste and magnificence.

FOR the first time in recent years the French Minister of Public Instruction is one of the leading members of the Cabinet. It is said that in the discussion on the new electoral law, M. Wallon intends to ask the Versailles Assembly to vote that ignorance be considered a disqualification, and that any elector be disfranchised who cannot read and write.

M. GEOFFROY SAINT-HILAIRE, the Director of the Jardin d'Acclimatation, Paris, has just instituted a new intermediate station for tropical plants at the Iles d'Hyères. Delicate plants will consequently not be taken at once from a hot to a cold atmosphere.

A MEMORIAL tablet, bearing an appropriate inscription, now marks the spot in Westminster Abbey where the remains of Dr. Livingstone are deposited.

A SCIENTIFIC Society has recently been established in Caius College, Cambridge, for the diffusion of scientific knowledge among the members of the College, for the reading of essays on scientific subjects, and for the holding of scientific discussions. The Society admits within the range of its discussions all sciences of observation. An interesting feature in the scheme of the Society's proceedings is that the first half-hour of each meeting is to be devoted to open discussion, to the answering of questions proposed by any member either at the time or at a previous meeting, or to the exhibition of specimens. The first president of the Society is Mr. B. Anningson, M.A., M.B., the newly-appointed Medical Officer of Health for Cambridge, and the secretary is Mr. Wm. Ewart. A number of papers have been read during the present term. The meetings have been well attended and the discussions well supported.

A SCIENTIFIC Society has been formed at Gloucester, chiefly in connection with the School of Science there, under the title of the Gloucester Philosophical Society. A programme of papers for the year has been issued. In addition to the regular monthly meetings, a course of six lectures on Structural Botany is being delivered by Mr. Allen Harker to the members of the Society. One or more excursions are to form a feature of the course. Gloucester has hitherto been rather apathetic than otherwise on science; this looks more healthy.

ON Nov. 23, at Balliol College, Oxford, there will be an examination for a Brackenbury Scholarship for the encouragement of Natural Science, worth 80*l.* a year for four years.

WE are very much surprised, and on all accounts it is greatly to be regretted, that the Legislature of Massachusetts has rejected the Bill for a new Survey of the State to which we have already referred. Massachusetts is known all the world over as being one of the most intelligent and best educated States in the Union. Evidently, however, the State schools are too strong in arithmetic; a Mr. Plunkett brought some extraordinary calculations before the House, showing that the Survey would cost nearly a million and a half of dollars and occupy nearly a hundred years! Besides an advanced and accomplished calculator, the Massachusetts Legislature is also happy in the possession of a "funny man," a Mr. Rice, who seems occasionally to relieve the severity of Mr. Plunkett's extreme calculations by bright flashes of buffoonery. Mr. Rice described the proposed Survey as "sending young men with muck-rakes to scratch the sterile soil of the State and make pictures."

THE Indian Museum at South Kensington was opened to the public on the 1st instant.

THE newly issued part of the Transactions of the Zoological Society of London contains an exhaustive memoir on the birds inhabiting the Philippine Archipelago, illustrated by twelve coloured quarto plates.

PROF. HALL GLADSTONE completed his course of lectures at the Royal Institution on chemical force on Tuesday, and exhibited a new compound he had just discovered, Zinc Ethylochloride, $Zn \left\{ \begin{matrix} C_2H_5. \\ Cl \end{matrix} \right\}$

THE necessity of utilising the large rivers for maritime navigation is becoming one of the questions of the day in France. The Municipal Councils of Lyons and Marseilles are considering the means of connecting Marseilles with the Rhône by a canal practicable for shipping; while the Municipal Council of Paris have appointed a commission to devise means to render the Seine navigable from Rouen to Paris.

PROF. DRAKE, the eminent Berlin sculptor, has just finished a colossal statue of Alexander von Humboldt, ordered by the city of Philadelphia; it is nine feet high, and will be shipped to its destination early in June.

A TELEGRAM, dated Berlin, May 28, states that the Tashkend Government has sent an expedition to Hissar, an unknown principality east of Shahrisiabsk, and north of the Afghan frontier. The members of the expedition are mostly scientific.

BAILLIÈRE, of Paris, has published an analytical "Table des Matières" of the first ten volumes (1864-74) of the *Revue Scientifique.* The Table forms a very useful index to much of the scientific work of the last ten years.

A THICK Supplement (No. 41) to *Petermann's Mittheilungen* has just been published, containing a multitude of statistics on the population of the earth, by E. Behm and H. Wagner. They estimate the total population of the globe at 1,396,842,000, distributed as follows:—Europe, 302,973,000; Asia, 798,907,000; Africa, 206,007,000; America, 84,392,000; Australia and Polynesia, 4,563,000.

HEFT VI. of *Petermann's Mittheilungen* contains a beautiful map illustrative of Dr. Rohlfs' travels in the Libyan Desert during 1873–74. It embraces the portion of North Africa between 25° and 29° N. lat., and 26° and 32° E. long. This map, along with the explanatory letterpress by Dr. Jordan and Dr. Rohlfs which accompanies it, will be found to add in a very important degree to an accurate knowledge of this hitherto imperfectly known region. The map shows the route not only of Rohlfs' expedition, but of Schweinfurth and several other explorers, from Krump (1701) downwards.

IN a paper by Prof. J. D. Dana, in the May number of Silliman's *American Journal*, on Dr. Koch's evidence with regard to the contemporaneity of Man and the Mastodon in Missouri, the author comes to the following conclusions:—Taking all things that have been reviewed into consideration, he thinks there is sufficient reason for regarding Dr. Koch's evidence of the contemporaneity of Man and the Mastodon *very doubtful.* He hopes that the geologists of the Missouri Geological Survey now in progress will succeed in settling the question positively. The contemporaneity claimed will probably be shown to be true for North America by future discoveries, if not already so established; for Man existed in Europe long before the extinction of the American Mastodon.

An interesting innovation has been tried with great success at the National Library of Paris. It has been suggested by M. Belliard, one of the principal librarians, who was appointed the head of the Receiving Office a few months ago, to publish a monthly paper containing a descriptive list of the works which have been presented to the library, or purchased during the preceding months. The works sent by the Home Office for the *dépôt legal* are not registered in that paper: there is for these a special publication. The first number has been issued, and is a lithographed 12mo pamphlet of thirty-two pages, having about two hundred entries. A copy will be presented to the great libraries abroad and in France.

Mr. A. J. Harvey, known to many as the advocate of various schemes of social improvement, now propounds a scheme for a "People's Museum of Physical Astronomy, to be erected and endowed by Government." "The object and design of a Museum of Physical Astronomy," Mr. Harvey states, "should be to popularise, familiarise, enlighten, and instruct the people in whatever can be illustrated, taught, and told, through the eye alone and without the aid or necessity of books, &c., of Physical Astronomy." It should be "a museum worthy of the intelligence and wealth of this great country, in which the whole visible universe is roughly presented to us, exhibited upon a colossal yet exact scale, and wherein the actual motions of the heavenly bodies are visible to the naked eye, wherein vast space can be spanned by the hand and great epochs of time counted with ease by the mind."

We have received from Messrs. Blackwood and Sons an interesting lecture by Dr. Page, entitled "Recreative Science; a Plea for Field Clubs and Science Associations." It ought to be circulated extensively among our field-clubs and other local scientific societies.

One of the most important of the many valuable U.S. Government documents published during a few months past is the Annual Report of the United States Geological and Geographical Survey of the Territories for 1873, as prepared by Dr. Hayden, being a volume of 730 pages, profusely illustrated with plates and sections, and exhibiting the physical geography, the sectional geology, the mining, and the natural history of the country. The volume consists of several sections. The first, that of Geology, Mineralogy, and Mining Industry, was prepared by Dr. Hayden, Mr. Marvine, Mr. Peale, and Dr. Endlich. The second embraces special reports on Palæontology, on the Fossil Flora, by Prof. Lesquereux, and on the Vertebrates by Mr. Cope. Part third, Zoology, contains articles on the recent Invertebrates, by Lieut. Carpenter, Dr. Packard, Baron Ostensacken, Mr. Ulke, Dr. Hagen, Mr. S. J. Smith, Prof. Verrill, and Mr. William G. Binney. Part fourth, upon the Geography and Topography, is from the pen of Mr. James T. Gardner, geographer of the expedition. There is also an appendix by Mr. A. R. Marvine.

The Rev. G. H. Hopkins gives the following method for fixing the curves which steel filings take when under the action of a bar magnet. The filings having been prepared so as to be as nearly the same size as possible, and that size very minute, are pound into a mortar, and a small quantity of finely powdered resin is added; these are stirred together until the two substances are completely mixed, and then, considerable pressure being exerted upon the pestle, they are rubbed until the resin adheres to the filings in a very fine coating. The filings can then be sprinkled as usual, and the curves formed. It is best (after the curves are formed) to heat the plane surface, glass, paper, or wood, according to convenience, over a stove or in an oven, which easily allow it to be sufficiently as well as uniformly heated. For projecting the curves on a screen, the following, we believe, is a very effective method. Cover the glass with thin gum-water, allow it to dry perfectly; obtain the curves on the dry gummed surface; finally, breathe on the plate: the gum is thereby softened and the curve permanently fixed. Substituting corresponding shaped pieces of paper for the magnets (a pinhole can be used to indicate the N. pole), the curves can be covered with a second plate of glass, and thus preserved as an ordinary lantern slide.

A very satisfactory report has been issued for the past year by the committee of the Devon and Exeter Albert Memorial Museum, &c. Several valuable additions in natural history have been made to the Museum, and in the reference library there has been an addition of eighteen per cent. in the issue of works on science and art. The institution as a whole continues to work so well that more room and better accommodation are urgently demanded.

The additions to the Zoological Society's Gardens during the past week include a Grey-cheeked Monkey (*Cercocebus albigena*), a Marsh Ichneumon (*Herpestes paludosus*), an Angolan Vulture (*Gypohierax angolensis*) from W. Africa, presented by the late Mr. H. Ansell; a Syrian Bear (*Ursus syriacus* from Western Asia, presented by Mr. W. Kirby Green; an Australian Cassowary (*Casuarius australis*) from Australia, presented by Mr. E. P. Ramsay; a Black-necked Stork (*Xenorhynchus australis*) from Australia, presented by Mr. C. Moore; two Egyptian Geese (*Chenalopex ægyptiaca*) from W. Africa, presented by Mr. R. B. N. Walker; three Chestnut-eared Finches (*Amadina castanotis*) from Australia, presented by Mrs. G. French Angas; a Common Raccoon (*Procyon lotor*) from N. America, presented by Mr. Wesson; a Reeves's Muntjac (*Cervulus reevesi*) born in the Gardens.

SCIENTIFIC SERIALS

The American Journal of Science and Arts, May.—The first article is a continuation (No. 5) of a series of notices on recent earthquakes, by Prof. Rockwood. The second is an inquiry by Prof. J. D. Dana on Dr. Koch's evidence with regard to the contemporaneity of Man and the Mastadon in Missouri. (See Note, p. 96.)—Mr. Carey Lea communicates a short note on the influence of colour upon reduction of light, and Prof. Rowland a description of a new diamagnetic attachment to the lantern.—The geological articles are the Primordial Strata of Virginia, by W. Fontaine, and the Age of the Southern Appalachians, by F. H. Bradley.—The contributions from the Physical Laboratory of Harvard College are on the construction of Gaugain's galvanometer, on a new form of magneto-electric engine, by W. R. Morse, and some remarks by S. Newcomb on the Transit of Venus.

The *Journal de Physique théorique et appliquée*, April 1875, contains the following original papers:—Researches on thermodiffusion, by J. Violle.—Determination of the velocity of light and of the sun's parallax, by M. A. Cornu.—On some polarisation experiments, by M. Bertin (last paper).—On an apparatus destined to get glass penetrated by the electric spark, by MM. Terquem and Trannin.—The number contains also several abstracts from papers taken from other serials.

Der Naturforscher, March 1875.—From this part we note the following papers:—On the influence of the density of metals upon their magnetisation; new researches made by Herr Börnstein with iron, nickel, and cobalt.—On the meteorite of Roda (in the Spanish province of Huesca), by Herren Tschermak and Lang.—On the genetic classification of the flora of Australia, by C. von Ettinghausen.—On the shooting stars observed on Nov. 13 and Dec. 10, 1874, at the Toulouse Observatory, under the direction of M. Gruey.—On vegetable mucus, by Herren Kirchner and Tollens.—On the action of hydrochloric acid upon lead-antimony alloys, by Herr H. v. d. Planitz.—On the behaviour of hydrocarbons under restricted oxidation, by M. Berthelot.—On the star system 61 Cygni; discussion of M. Flammarion's latest papers on the subject.—On the repulsive power of comets, by G. V. Schiaparelli.—On the respiration of Fungi, by Herr Müntz.—On over-saturated solutions and the dissociation of salts in solution, by A. Tscherbatschew.—On forests, the courses of rivers, and atmospheric moisture, by L. Fautrat.—On the radiation of the sun; observations made at the Observatory of Montsouris, near Paris, by Marié-Davy.—On the time of reaction of the sense of taste at the tip of the tongue, by Herren M. v. Vintschgrau and J. Hönigschmied.—On colouring matters and the sensitiveness towards light of several silver salts, by H. W. Vogel.—On the decomposition of vegetable xanthophyll by light, by J. Wiesner.—On the circulation of ammonia in the atmosphere, by Herr Al. Schloesing.—On some glacier-phenomena in the Bavarian high plateaus; a communication made to the Munich Academy, by Herr Zittel.—Researches on the process of digestion in the intestines of sheep, by Eugen Wildt.—Some researches on magnetism, by M. Bouty.—On the antiseptic properties of salicylic acid; an extract from the *Journal für praktische Chemie*, by Herr Kolbe.—On the direct observation of the atmosphere of Venus, by C. S. Lyman; results of these observations show the horizontal refraction of Venus' atmosphere to be 44′·5; in 1866 it had been determined at 45′·3, and Mädler in 1849 had found it 43′·7. Mr. Lyman measured the diameter of the planet six times on Dec. 10 (the day after the transit), and found it on the average to be 63″·1; the average of eleven measurements on Dec. 11 was 63″·75.—On the electric action of a thermal source at Baden, Switzerland, by Herren Thury and Alb. Minich.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, March 15.—On the relation between differences of atmospheric pressure and velocity of wind, according to the theories of Ferrel and Colding, by Dr. Hann. The author begins with a review of the two theories of storms, the older of which has been accepted chiefly in Germany, the other in America and the Northern States of Europe. According to the former, whirlwinds are formed mechanically by different streams of air meeting, and centrifugal force causes the central depression. The more modern theory regards a local depression as the first condition, causing an indraught resulting in a whirlwind through the earth's rotation. The primary depression is held to follow condensation of vapour. Probably there is something right in each of these views. Eddies can, doubtless, be formed by currents meeting at certain angles, but the direction of rotation would not be invariable in each hemisphere. Besides, the mechanical resistance to the progress and continuance of a whirlwind so formed would, without inconceivably favourable conditions, be far too great to be overcome. Dr. Hann recognises the part played by vapour in storms, but thinks that many meteorologists rely too much on it in their need, and points to the works of Hopkins and Laughton for instances of this partiality. He believes that the greater part of the low pressure which accompanies storms must be explained by mechanical laws, and that the local differences of pressure in a cyclone or even in a straight-blowing current (if such there be) follow from movements of the air. Condensation may cause a depression, and that depression we know may cause winds which produce a depression ten or fifteen times greater. Prof. Ferrel endeavours to show mathematically that depressions are due to centrifugal force and the earth's rotation. Colding considers tropical hurricanes as true whirlwinds, and his values for pressure from centre to edge reckoned from this hypothesis agree with observation. Now, there is no reason why centrifugal force should not act in spirally-whirling storms in relation to radius and velocity. The earth's rotation adds to the effect of this force, and the result is a diminution of pressure towards the centre on the earth's surface. The enormous extent of some minima is thus explained, which an ascending current and precipitation fail to account for. Dr. Hann proceeds to develop mathematically the theories of Ferrel and Colding, and gives the following formula (1) for finding the barometric gradient:—

$$\triangle B = \frac{l}{287 \cdot 4} \cdot \frac{B}{T}(2n \sin. \phi + u)v$$

where B is the height of the barometer at point of observation, T the absolute temperature (*i.e.* $273^\circ + t$), $l = 50$ geographical miles, u the angular velocity of rotation, n the angular velocity of the earth's rotation, ϕ the latitude, and v the distance traversed in unit of time. In this equation it is assumed that the circulation is simple, without friction, and not inducing new masses of air.—In the *Kleinere Mittheilungen* we have an article on Baumhauer's Meteorograph, and some extracts from a letter of Prof. Mohn, dated 21st December last, on cyclonic minima. In this letter the writer states that having called the attention of Herr Guldberg to the fact that Colding's point of view is quite different from that of the new school of meteorologists, that gentleman worked out his own formula and found as much agreement between his results and observations of an Antilles hurricane as Colding found by his method. The factors taken into consideration by Herr Guldberg were, barometric gradient, rotation of the earth, centrifugal force, and friction of the air. Prof. Mohn believes the central minimum to be a mechanical effect of rotation. He discovered lately that Prof. Ferrel had worked with similar formulæ and had derived therefrom similar results, but he intends to pursue his task, and believes it will be ascertained that relations of pressure are in great part functions of movement.

THE *Bulletin Mensuel de la Société d'Acclimatation de Paris* for February gives the customary yearly summary by M. Quihou of the principal experiments carried out in the Jardin d'Acclimatation in the Bois de Boulogne during 1874, and of the most important plants cultivated there.—M. Jeannel gives a report on various experiments conducted by him during the year in the Jardin de Luxembourg with the object of testing the value of mineral manures in horticulture.—The new kind of silkworm, *Attacus Yama-mai*, is the subject of a long paper by M. F. A. Bigot.—An attempt made by M. Victor Fleury to acclimatise the Siberian rabbit in France has not entirely succeeded, but excellent results have ensued in the crossing of this race with the common grey rabbit of the country.—The value of the *Eucalyptus globulus* in correcting the unhealthiness of marshy and other lands is proved by its effect in certain parts of Algeria, where, in the neighbourhood of Lake Fezzara, in Constantine, a large area of land hitherto noted for its insalubrity has greatly improved since the plantation of a large number of these trees.

Annali di Chimica applicata alla Medicina, Feb. and March, 1875.—These numbers contain the following papers:—On diastase and some preparations from malt, by H. Duquesnel.—On croton-chloral, by Engel.—On a carbonic solution of tribasic phosphate of lime, by Chevrier.—On a glycerine solution of iodide of potassium, by C. O. Barberis.—On the ventilation of closed localities, by G. P.—On vinic alcohol, aldehyde, and ethers: experimental researches made in the Physiological Laboratory of Padua, by Drs. P. Albertoni and F. Lussana.—On ferments and fermentations in the human organism, by A. Pavia.—On some fermentation processes by J. Macagno.—On a simple, easy, quick, and certain means to distinguish in mankind real death from apparent, by Dr. A. Monteverdi. This consists of injecting under the skin an aqueous solution of ammonia, and watching the appearance of the blister produced.—On blood fibrine and the formation of a substance analogous to ordinary albumen, by A. Gautier.—Researches on the parasite that produces whooping-cough, by Dr. Lebrerich.—On apomorphia, by G. Hirne.—A note on cremation, by the editor of the *Annals*, Dr. G. Polli.

THE *Gazzetta Chimica Italiana*, fasc. iii. 1875, contains the following papers:—On the action of acetyl chloride upon santonine and santonic acid, by F. Sestini.—On some derivatives from alphatoluic acid, by C. Colombo and P. Spica.—On the formation of sugar in fruits, by M. Mercadante.—On a new method of determining the tannic acid contained in wines, by A. Carpané.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, May 6.—Anniversary Meeting.—Dr. G. J. Allman, F.R.S., president, in the chair.—The officers of the Society were elected for the ensuing year as follows, viz.:—President, Dr. G. J. Allman, F.R.S.; Treasurer, Dr. J. Gwyn Jeffreys, F.R.S.; Secretaries: T. Currey, F.R.S., and St. George Mivart, F.R.S.; and as Members of the Council: Dr. J. D. Hooker, Pres. R.S.; Dr. J. G. Jeffreys, F.R.S.; Major-General Scott, C.B.; R. B. Sharpe, and Chas. Stewart, in the place of J. Miers, F.R.S., T. P. Pascoe, Major-General Strachey, F.R.S., Dr. H. Trimen, and the late D. Hanbury, F.R.S. The President then delivered an address on the History and Development of the Infusoria.

Anthropological Institute, May 25.—Col. A. Lane Fox, president, in the chair.—Mr. T. G. B. Lloyd read papers on the Beothucs of Newfoundland, and on the Stone Implements of Newfoundland. The first paper was a continuation of one read the previous session, and contained the further experiences of the author in Newfoundland, which island he had recently revisited. The Beothucs possessed several of the characteristics belonging to many of the tribes inhabiting North America, whilst they differed from them in the following peculiarities:—Lightness of complexion, the use of trenches in their wigwams for sleeping places, the peculiar form of canoe, the custom of living in a state of isolation apart from the white inhabitants of the island, and their persistent refusal to submit to any attempts made to civilise them. They were also remarkable for their inability to domesticate the dog.—Prof. Busk communicated a paper on two Beothuc skulls, and described them as presenting all the characteristics of the normal brachycephalic form of the Red Indian skull.—In his second paper Mr. Lloyd described the stone implements he had brought from Newfoundland, consisting of axes, chisels, gouges, spear and arrow heads, scrapers, fish-hooks; also cores, flakes, whetstones, rubbing stones, sinkers, and stone vessels.—Mr. Park Harrison exhibited and described five photographs, from Tahiti, of Easter Island wooden tablets; and Mr. H. Taylor exhibited a series of fine photographs of people inhabiting the South Sea Islands.

Royal Horticultural Society, May 12.—Scientific Committee. A. Murray, F.L.S., in the chair.—The Chairman made a communication with respect to the acarus to which Prof. Thiselton Dyer had drawn attention as destroying the female flowers of the Yew. He believed it to be undescribed, and proposed for it the name of *Tetranychus taxi*. It was allied to the acarus which Prof. Westwood had described as very injurious to the young buds of the currant.—Mr. M'Lachlan exhibited specimens of wallflower in which the petals were virescent.—Dr. Masters showed leaves of the vine (from a nursery in the neighbourhood of London) bearing galls produced by Phylloxera.—Prof. Thiselton Dyer called attention to a paper by Dr. Franz Low, translated in the current number of the *Annals and Magazine of Natural History*. It described a nematoid worm (*Tylenchus Millefolii*), which produced the galls on the rachis of the leaves of the common Milfoil.—Prof. Thiselton Dyer exhibited three flasks which contained Pasteur's solution, all three of which had been subjected to boiling. The neck of No. 1 flask, treated on March 3, 1875, was plugged, while the contents were still boiling, with cotton-wool, and the fluid remains clear and unaffected. In flask No. 2, otherwise similarly treated, but without any plug, so that access of air and therefore of spores was allowed, there was a dense growth of mould (*Penicillium*). In No. 3, boiled on Sept. 30, 1873, but in which the plug was removed for five seconds only on Oct. 15, 1874, a dense mould had made its appearance.

General Meeting.—W. Burnley Hume in the chair.—Prof. Thiselton Dyer called attention to the principal objects exhibited.—A fine potful of the rare Irish Butterwort, *Pinguicula grandiflora*, was shown by Mr. Dean. *Senecio macroglossus*, an evergreen greenhouse climber shown by Mr. Green, had foliage identical with that of some forms of ivy; it was a native of the Cape.—A ripe fruit of *Stephanotis floribunda* was sent by R. T. Coombe, Taunton. Morels, which are abundant this year, were represented by a fine series of *Morchella crassipes*, sent by J. Barclay, The Durdans, Epsom.

Physical Society, May 22.—Prof. Gladstone, F.R.S., president, in the chair.—Mr. Spottiswoode, F.R.S., exhibited and described a revolving polariscope. A luminous beam passes from a small circular hole in a diaphragm through a polariscope, the analyser of which is a double image prism, the size of the hole being so arranged that the two luminous discs shall be clear of each other. If the prism be made to revolve rapidly, one of the discs revolves round the other and is merged into a ring of light, which is interrupted at opposite sides by a dark shaded band, the position of which depends upon the position of the original plane of polarisation. The discs may be coloured by inserting a selenite plate, and the rapid revolution of the analyser then gives alternating segments of complementary colours; or, if a quartz plate be used, the rotating disc passes successively twice in a revolution through all the colours of the spectrum, and when the revolution is rapid, merges into a prismatic ring. The effect of the interposition of a $\frac{1}{4}$-undulation plate, which converts plane into circularly polarised light, was then shown, and Mr. Spottiswoode also interposed a concave plate of quartz, and exhibited the effect of rotation on the characteristic rings of quartz.—Prof. Adams exhibited a polariscope adapted for showing the optic axes of crystals in which they are much inclined to each other, as in the case of topaz. The part of the instrument by which this is effected consists of a frame in which the crystal is supported between two hemispherical lenses, the common centre of which is at the centre of the crystal. The frame is capable of motion round an axis at right angles to that of the instrument. By this means each of the axes can be brought under the cross wires, and the space through which the frame is moved affords a means of determining the angle between the axes of the crystal. The crystal may be immersed in a liquid in cases in which its optic axes are too far apart to be seen in air.—Dr. Mills made a verbal communication on fusion-point and thermometry. His apparatus for fusion-points consisted essentially of a beaker, in which stood an inverted funnel, the shortened stem of which carried a test-tube, supported by a contraction at its base. The test-tube contains naphtha of high boiling-point, and the thermometer and capillary tube containing the substance occupy its centre; the funnel has four equidistant semicircular cuts at the end of its stem, and six on its lips; the beaker is nearly filled with strong oil of vitriol, and has a wooden cover; on the application of heat below the beaker, warm oil of vitriol ascends in the funnel, and cold oil of vitriol descending, enters at the lip; thus an automatic stirring is kept up, and the mercury in the thermometer rises so regularly as to appear perfectly continuous in course, even under considerable magnifying power. The manner of preparing and filling the capillary tubes was described. Attention was then drawn to the "zero error" of thermometers. In thermometers which have not been much used, the zero error must always be determined immediately after experiment. It is also generally necessary to correct for the projection of the thermometer beyond its bath. This correction has been experimentally determined by the author, and required from 1,500 to 2,000 observations of temperature for each of four instruments used. It was ascertained that the well-known expression—

$$C = \cdot0001545\,(T - t)N$$

given by Regnault and Kopp is not supported by actual trial. If we write the expression thus—

$$C = x(T - t)N$$

experiment shows that x depends on the length N exposed, and

$$x = \alpha + \beta N$$

For lengths of about 25°, x is about ·00013, and increases about ·0001 for every additional 25°. The exact values of α and β require, however, to be ascertained for each instrument.—Mr. Bauerman, F.G.S., described and illustrated a very simple method for ascertaining the electric conductivity of various forms of carbon. The method, which was originally devised by Dr. von Kobell, consists in holding a fragment of the substance to be tested with a strip of zinc bent in a U-form, and immersing it in a solution of copper sulphate. In the case of a bad conductor a deposit of copper takes place solely on the surface of the zinc, but when a good conductor is employed a zinc-carbon couple is formed, and a deposit takes place on the surface of the carbon. Numerous specimens were exhibited which showed that the conducting power is greatest in coal which has been subjected to a great degree of heat, and the lowest temperature at which this change takes place appears, in the case of anthracite, to be between the melting points of zinc and silver. Such experiments appear to be specially important as giving a clue to the temperature at which anthracitic metamorphism has been effected by the intrusion of igneous rock.—Prof. Woodward exhibited an apparatus for building up model cones and craters. It consists of a wooden trough about 18 inches long, with sloping sides; at the bottom of the trough a bladed screw carries forward the ashes, sawdust, or other material used, to an opening through which air from a powerful bellows is forced upwards. A board 3 or 4 feet square, with a hole in the centre, is placed over the air-jet, and on this the crater is formed. Several of the peculiarities of natural cones may thus be illustrated, and their structures shown, by using sawdust of various colours.

WELLINGTON, N.Z.

Philosophical Society, Feb. 10.—Dr. Hector, F.R.S., in the chair.—The annual report by the Council (adopted as read) congratulated the Society upon its prosperous condition, not only in regard to the great increase in the number of members, but upon the growing interest taken in the work of the Society, as indicated by the large attendance at the meetings of the past session, and by the number of interesting papers read and discussed by members. There are now 161 names on the books, twenty-two new members having been elected since January 1874. Seven general meetings were held, and thirty-two papers read on the following subjects:—*Geology*.—1. Did the Great Cook River run N.W. or S.E.? Mr. Crawford. 2. On the Tertiary Series of Wanganui, Mr. Purnell. 3. On the microscopic structure of the igneous rocks of New Zealand, Richard Daintree. 4. On the Pleistocene glaciation of New Zealand, Mr. Travers. 5. Changes in the physical geography of New Zealand since the arrival of the Maoris, Mr. Hood. *Zoology*.—1. Description of fish, presented to the Museum by Prof. Wyville Thomson, Dr. Hector. 2. On new fish from Chatham Islands, Dr. Hector. 3. On certain disputed points in New Zealand Ornithology, Dr. Buller. 4. On New Zealand whales, Dr. Hector. 5. On *Plotus novæ hollandiæ*, Dr. Buller. *Botany*.—1. On a new species of *Rubus*, by Mr. Buchanan. 2. On the durability of New Zealand timber, Mr. Buchanan. 3. On *Juncus camprocarpus* and a new species of Isoetes, Mr. Kirk. 4. On new species of mosses, Dr. Knight. 5. Flowering plants and ferns of Chatham Islands, Mr. Buchanan. 6. Description of New Zealand lichens, Dr. Knight. 7. Two plants new to New Zealand, *Lepilæna preissii* and *Carex chlorantha*, Mr. Kirk. *Meteorology*.—1. On solar radiation in New Zealand, Mr. Rous Marten. 2. On the hot winds of Australia and their influence on the climate of New Zealand, Mr. Hood. 3. On the hot winds of Canterbury, Mr. M'Kay. *Chemistry*.—Five papers pointing out certain new discoveries in chemistry, Mr. Skey. *Miscellaneous*.—1. On ergot in rye, Dr. Hector. 2. On portion of a wreck found at the Haast River, Capt. Turnbull. 3. On the identity of the Moa hunters with the present Maori race, Mr. M'Kay. 4. On Maori traditions respecting the Moa, Mr. Hamilton. 5. On the longitude of Wellington Observatory, Capt. Nares, of H.M.S. *Challenger*. 6. On the Duplex system of telegraphy, Mr. Lemon. These papers will all appear in the seventh volume of the "Proceedings and Transactions of the New Zealand Institute," which is now going through the press. The balance-sheet showed a credit of 162*l*., of which Dr. Hector was requested to expend 100*l*. in purchasing standard works of reference in England.—The Chairman announced that Prof. Wyville Thomson, Prof. Newton of Cambridge, and Robert M'Lachlan, all of whom had taken great interest in New Zealand science and added much to its literature, had been elected honorary members of the New Zealand Institute. Dr. Buller, F.C.S., F.G.S., was elected president for the ensuing two years. Mr. Travers, F.L.S., vice-president, then took the chair, and the following papers were read:—Further proofs of the former existence of the Great Cook River, by J. C. Crawford, F.G.S.—Notes on Hutton's "Catalogue of Marine Mollusca of New Zealand," by Dr. Ed. von Martens.—On some additions to the collection of birds in the Colonial Museum, by Dr. Buller.—Additional notes on New Zealand fishes, by Dr. Hector.—Further notes on New Zealand whales, by Dr. Hector.—Mr. Travers said that the visit of Dr. Hector to Europe with a valuable collection of specimens of natural history and other objects would materially advance the cause of science in New Zealand.

PHILADELPHIA

Academy of Natural Sciences, Sept. 15, 1874.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy made some remarks on the moving power of diatomes, desmids, and other Algæ. While the cause of motion remains unknown, some of the uses are obvious. The power is considerable, and enables these minute organisms, when mingled with mud, readily to extricate themselves and rise to the surface, where they may receive the influence of light and air. In examining the surface-mud of a shallow rainwater pool, in a recent excavation in brick clay, he found little else but an abundance of minute diatomes. He was not sufficiently familar with the diatomes to name the species, but it resembled *Navicula radiosa*. The little diatomes were very active, gliding hither and thither, and knocking the quartz sand-grains about. Noticing the latter, he made some comparative measurements, and found that the Naviculæ would move grains of sand as much as twenty-five times their own superficial area, and probably fifty times their own bulk and weight, or perhaps more.—Dr. J. Gibbons Hunt remarked that in the vegetable kingdom it is exceedingly rare to meet with glands which have distinct excretory ducts. Some authors deny their existence entirely; but in *Nepenthes rafflesiana*, *N. distillatoria*, and *N. phyllamphora*, and probably in all the species, are large cylindrical glands which pour out their secretion through distinct excretory ducts.

PARIS

Academy of Sciences, May 20.—M. Frémy in the chair.—The following papers were read:—Observations of the moon, made with the meridian instruments of the Paris Observatory during 1874, communicated by M. Leverrier.—Some remarks on the discussion with regard to cyclones, by M. Faye.—Researches on sun-spots and solar protuberances made during the years 1871 to 1875, by Father Secchi.—Conditions of the maximum amount of work produced by heat-engines, by M. A. Ledieu.—M. André read a paper on the scientific results obtained at Nouméa by the Transit party.—On the determination of singularities of the left curve, at the intersection of two surfaces of any order that have a certain number of multiple points in common, by M. L. Saltel.—A note by M. V. Cornil, on the dissociation of the violet of methylaniline and its separation into two colours under the influence of normal and pathological tissues, particularly by tissues inclined to amyloid degeneration.—Application of the graphical method to the study of the mechanism of swallowing, by M. S. Arloing.—On a new proceeding in the operation of the cataract (extraction by means of a peripherical piece of cloth), by M. L. de Wecker.—Sulphuration of copper and of iron by a prolonged presence in the thermal source of Bourbon-l'Archambault, by M. de Gouvenain.—On the wanderings of the oak Phylloxera, by M. Lichtenstein.—On some reactions of chromium salts, by M. A. Etard.—On Camphenes, by M. J. Riban.—A note by MM. C Saint-Pierre and G. Jeannel, on a reaction of carbon bisulphide; conversion of carbon bisulphide into hydro-sulphocyanic acid.—On the influence of the pressure in the atmosphere upon the life of man, by M. Cl. Bernard.—Researches on the respiration of birds, by the same and M. Campana.

BOOKS AND PAMPHLETS RECEIVED

British.—The Pebbles in a Bolton Brick field. A Lecture by Rooke Pennington, B.A., LL D. (*Bolton Daily Chronicle*).—Report of the Rugby School Natural History Society for 1874.—Notes on the Fertilisation of Cereals (Botanical Society of Edinburgh).—On the Graphical representation of the movements of the Chest Wall in Respiration: A. Ransome, M.D., M.A. (Taylor and Francis).—Arctic Papers for the Expedition. A selection of Papers on Arctic Geography and Ethnology. Printed and presented to the Arctic Expedition of 1875 by the Royal Geographical Society (John Murray).—A Compendious Statement of the Nature and Cost of certain Sewage Processes: Major-General Scott, C.B.—Ornithology of the Straits of Gibraltar: Lieut.-Col. L. Howard and L. Irby, F.Z.S. (R. H. Porter).—Contributions to Natural History and Papers on other Subjects: James Simpson (Edinburgh Publishing Company).—Recreative Science: David Page, LL.D. (Wm Blackwood).—Transactions of the Norfolk and Norwich Naturalists' Society, 1874–75. Vol. ii. Part i.—The Potato Disease: Eccles Haigh (G. Philip and Son).—Chapters on Sound: C. A. Martineau (Sunday School Association).—The Zoological Record for 1873 (John Van Voorst).

Colonial.—General Report on the Operations of the Great Trigonometrical Survey of India during 1873–74: Col. J. T. Walker, R.E., F.R.S., &c., Superintendent of the Survey (Dehra Dun, M. J. O'Connor).—Proceedings of the Annual Meeting of the Members of the Agri-Horticultural Society of Madras on the 24th and 27th of March, 1875.

American.—Centrifugal Force and Gravitation. Part I.: John Harris (Lovell Printing and Publishing Company).—The Surface Geology of Ohio, U.S. (Columbus, O.; Nevins and Myers).

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THURSDAY, JUNE 10, 1875

THE METEOROLOGICAL OFFICE

Quarterly Weather Report of the Meteorological Office. Published by the authority of the Meteorological Committee, January 1869, to September 1873. Hourly Readings from the self-recording instruments at the seven Observatories in connection with the Meteorological Office, January to September 1874.

THE self-recording instruments which have been in operation at the seven Observatories of the Meteorological Committee since January 1869, may be regarded as the best and most complete anywhere existing for recording continuously the atmospheric pressure, temperature, humidity and rainfall, and the velocity and direction of the wind. To ensure correctness in the work, and accurate tabulation of the results, minute regulations with respect to the officials at the outlying Observatories, the assistant at the Central Observatory, and the director of the Central Observatory, were laid down in the Committee's Report for 1868, p. 62. Thus, as regards the thermograph, twenty-seven regulations were laid down, one of the most important of these being the 25th, by which it was provided that forty remeasurements from each month's curves were to be made at Kew, the central Observatory; and a table is given (page 39 of the same Report) of the results of measurements which were specially designed for the detection of *small errors* in the thermograph tabulations, from which it appears that refinements as minute as the one-hundredth of a degree of temperature were taken cognisance of in the results.

Tracings of the curves, and five-day and monthly results of the tabulations, though not the tabulations themselves, have been published, beginning with 1st January, 1869; and since then many and great improvements have been made in representing the curves on the Plates, all in the direction of greater clearness and precision, for which the Committee deserve our best thanks. Among the many valuable results of these curves we may point to the high temperature at Glasgow on the 21st April, 1873, in connection with the remarkable changes in the direction and force of the wind which occurred at the time; to the heavy rainfall at Valencia on the 2nd July, 1873, in connection with the changes of wind, temperature and pressure; and to the minute oscillations of pressure at almost all the Observatories on the 3rd and 4th July, 1873, in connection with the changeable weather at the time. In these connections the absence of any observations of clouds is, however, a serious defect.

One of the principal objects for which the seven Observatories were established was to furnish the data of observation for the determination of the meteorological "constants" for pressure, temperature, rainfall, &c., for different parts of the British Isles. This being now the seventh year in which this expensive system of observation is going forward, it may be well to inquire how far the information, as published by the Meteorological Office, meets the requirements of the problems to be solved.

Assuming that the curves are correctly traced from the photographs, we may inquire whether the figures tabulated from these, under the regulations referred to above, be satisfactorily accurate. No hourly values having been printed before January 1874, the question can only be answered by an examination of the printed monthly maxima and minima, with the days and hours of their occurrence, as compared with the curves. The following Table, giving the extreme readings of the thermometer for each of the Observatories for January 1869, is here reprinted verbatim from the Quarterly Weather Report for 1869, Part I., p. 34:—

	Maximum.	Day and Hour.	Minimum.	Day and Hour.
Valencia ...	53°·7	4th, 4 A.M.	37°·0	22nd, 3 A.M.
Armagh ...	53°·1	16th, 2 P.M.	31°·9	26th, 2 A.M.
Glasgow ...	50°·1	5th, 10 A.M.	29°·5	26th, 7 A.M.
Aberdeen ...	48°·8	31st, 6 P.M.	30°·6	26th, 8 A.M.
Falmouth ...	54°·0	30th, noon.	36°·0	24th, 9 A.M.
Stonyhurst...	51°·8	31st, noon.	28°·4	25th, 2 A.M.
Kew	55°·3	30th, 6 P.M.	27°·6	25th, 7 A.M.

Each datum of this table we have compared with the temperature curves for the month, measuring each observation four times, viz., by the side scales of each curve from below upwards, and from above downwards. Setting aside every reading which does not differ from the measured reading so much as 0°·4 of a degree, and the discrepancies which appear to arise from the unequal shrinkage of the paper as indicated by the results of the four measurements, there are in the above Table twelve errors, the maxima at Falmouth and Kew being doubly wrong, the amount at the given hours being wrong, and the date of occurrence being also wrong. The following is the Table as corrected, the corrected readings being shown by asterisks:—

	Maximum.	Day and Hour.	Minimum.	Day and Hour.
Valencia ...	53°·7	* 5th, 4 A.M.	37°·0	22nd, 3 A.M.
Armagh ...	*53°·6	16th, 2 P.M	*32°·3	26th, 2 A.M.
Glasgow ...	*50°·9	5th, 10 A.M.	*27°·0	* 1st, 2 A.M.
Aberdeen ...	48°·8	31st, 6 P.M.	*28°·7	* 1st, 4 A.M.
Falmouth ...	*54°·9	*31st, 11 P.M.	36°·0	24th, 9 A.M.
Stonyhurst...	51°·8	31st, noon.	*22°·8	* 1st, 8 A.M.
Kew	*55°·8	*31st, 1 P.M.	27°·6	25th, *5 A.M.

It will be observed that the errors are of three sorts—(1) errors of temperature and errors of the date of occurrence of the maxima and minima, including (2) errors of the day of the month, and (3) errors of the hour of the day. Similarly the other months of 1869 have been examined, with the result that forty-one errors of temperature varying from 0°·4 to 9°·6 † have been detected, that the day of the month, as printed, is wrong on twenty-two occasions, and that the hour of the day is wrong in nine cases, in which the temperature and day of the month are correct—in all, seventy-two errors. The Tables and curves for ten months, taken indiscriminately from the other years, have also been examined.

In the Tables for April and June 1870 (p. 37 of the Quarterly Weather Report of that year) there occur six errors in each of these months, and in the Table for March 1871 (p. 26 of Q. W. Report for 1871) there occur seven errors. In none of the twenty-two months examined are there

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† The minimum temperature at Glasgow for October is given as 39°·9 at p. 109 of Q. W. Report, instead of 30°·3 as by the curve of temperature (Plate cxix.).

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fewer than two errors. This is the number of errors in the Table for August 1873 (p. 42 of Q. W. Report for 1873), being the last month for which the whole of the curves have been published. One of these two errors has reference to the minimum temperature for Aberdeen (39°·2) which occurred at 4 A.M. of the 11th August, and regarding which the following remark is made in a footnote :—"Doubtful; instrument out of action immediately after 6 A.M." If we turn to the Aberdeen temperature curve of the 11th (Plate xlv.), we see that the instrument was not out of order during the whole of that day; and by examining the curve for the whole month, we see further that the instrument went out of action on no day at 6 A.M., and that on the six occasions on which it was out of order during the month, it is highly probable that in none of the cases did the temperature fall so low as 39°·2.

Tables of errata for 1869 have been published by the Office from time to time, the last one appearing in November 1874. Not one of the numerous errata referring to 1869, as well as those referring to the other years, which have been detected in this examination, has yet appeared in the Tables of errata published by the Office. Furthermore, these Tables of errata are themselves repeatedly in error; thus, the last one, printed on the title-leaf of the Quarterly Weather Report for July—Sept. 1873 contains in the five lines which compose it no fewer than three mistakes; viz., 1874 being twice printed for 1873, and the hour of occurrence of the minimum at Glasgow being curiously printed as 0^h 2 A.M., whereas the month began with the minimum temperature.

As the curves for 1874 are not yet published, there are no means of checking the hourly tabulated readings from the curves. Referring, however, to the regulations laid down for the detection and correction of *small errors*, and to the minute refinement to which the results were to be carried, viz., to the hundredth of a degree, we were led to expect that the tabulated readings would be taken from the curves with an approach to accuracy of at least the tenth of a degree. A slight inspection of the figures of the tabulated readings shows at once that this is not the case, with the single exception of the Observatory at Stonyhurst.

A word will explain our meaning. There being no reason why any one of the ten decimal figures, viz., ·1, ·2, ·3, . . . ·8, ·9, ·0 should occur oftener than another, it is evident that on the mean of, say, a month's observations, the number of times on which a reading of a whole degree occurred would be, approximately, a tenth of the whole number of readings. At Kew, however, out of the whole 744 readings for January 1874, 172 whole degrees were read off from the curves and have been printed in the Tables; in other words, nearly 100 in excess of a due proportion. Next month matters improved at Kew, and only 87 whole-degree readings are given; in March they rose to 127, and fell again in April to 94. In this respect Kew shows the greatest irregularity of all the Observatories, but more especially as regards the tabulations from day to day—showing in this respect a marked contrast with the regular business-like tabulations of Stonyhurst. Summing up all the whole-degree readings at each of the Observatories for the nine months, and comparing the results with a tenth part of all the readings tabulated, we obtain the following results :—At Stonyhurst the number of whole-degrees read off were 16 per cent., *less* than a tenth part of the whole; at the other observatories the numbers are *greater* than a tenth part of the whole, in the following order: Kew, 50 per cent.; Aberdeen, 95 per cent.; Armagh, 112 per cent.; Falmouth, 137 per cent.; Valencia, 147 per cent.; and Glasgow, 148 per cent. Every statistician will know the meaning of these figures, and how completely they destroy the scientific character of the work. It should moreover be kept in mind that 1874 was the sixth year of the tabulation by the Observatories of the readings taken from the curves. The method of tabulation as carried out is too rough for the determination even of the temperature daily "constants"—a statement which will be self-evident from the following hourly mean values for Valencia for the month of July 1874, beginning with 1 A.M.: 57°·7, 57°·5, 57°·3, 57°·2, 57°·1, 57°·6, 58°·7, &c.; the curve for the time from 2 to 5 A.M. cannot be determined from observations in which whole degrees so largely preponderate. Though the instrumental arrangements for the continuous registration of the temperature at the Committee's seven Observatories may well be regarded as a triumph of science, yet the results, as tabulated and published, can scarcely lay claim to a higher value than eye-observations of third-rate observers.

In view of the results of this examination, it is not easy to see how one can make a scientific use of the tabulations, and results deduced therefrom, as made by this department of the Office, until (1) the tracings of the curves from the photographs, (2) the tabulations of the hourly values from the curves, and (3) the monthly and five-day means, have been carefully revised.

It cannot be said that the publications have been issued under a press of work in the Office, seeing that the Quarterly Weather Reports have been published just when the Office has been ready to do it. The last published Report is for the quarter ending September 1873, and the last quarter of 1871 only appeared in November last. Further, at page 66 of the Report for 1873, giving a list of persons in the employment of the Meteorological Committee, we learn that at the time of going to press the number so employed was twenty-four, and the sum expended in the year for their salaries amounted to about 3,727*l.*, to which, if we add 2,722*l.* for expenses at Observatories (Report for 1873, p. 32), it is evident that there can be no reasonable doubt that the staff available for this work is amply sufficient.

There is a question yet remaining to be considered, viz., Are the thermometers at these Observatories in positions which will fairly indicate the march of the temperature of each place through the hours of the day; and, above all, are they so placed as to be comparable with each other? In the Introduction to the Quarterly Weather Report for 1870, pp. iii. to vii., woodcut illustrations are given of the thermometer screens, with their positions and surroundings. No two of these are alike—the only approach to uniformity being Stonyhurst and Glasgow. Two of the Observatories, viz., Valencia and Falmouth, occupy important positions near the sea, and might have yielded valuable results with regard to the influence of the sea on climate, but they have been placed in situations so confined that their temperature observations are of little value considered as contributions to a scientific inquiry into the climate of these islands.

The Council of the Scottish Meteorological Society, in a report dated 3rd July, 1872, drew attention to the positions of the thermometers, particularly those at Aberdeen which are forty-one feet above the ground and surrounded with buildings; giving it as their opinion that "observations so made were not comparable with each other, nor with other observations."* The publication since, by the Committee, of the hourly readings, enables us to examine the point from the observations themselves. One of the best marked phases of the daily temperature, as well as one of the most important, both for scientific and practical purposes, is the increase which takes place from 9 A.M. to 3 P.M. At Kew the mean increase between these two hours for January and February 1874 was 4°·8, and for June and July 6°·7—the greater increase in the summer months being in accordance with the climatic facts. But at Aberdeen the thermometers indicated between the same hours a mean increase of 3°·7 for January and February, and 1°·8 for June and July; thus, instead of being larger in summer, the recorded difference was only half that recorded in winter. It is needless to remark that these results for Aberdeen cannot represent the temperature of this part of her Majesty's dominions, and that for the supplying of data for temperature "constants" for that part of North Britain, the observations made there are worse than useless. The arrangements for the thermometers at the seven Observatories, both as regards height above the ground, and exposure, call for reorganisation.

In Part I. of the Quarterly Weather Report for 1870 (App. pp. 8–10) appears a valuable Table of the mean monthly readings of the barometer at the Committee's telegraphic stations. If we were sure that the method of annual inspection of these stations is a sound one, the results for Holyhead might suggest an inquiry into the influence of the sea on the state of the barometer. The position of the rain-gauges above the ground at these stations, which varies from five inches to 23 feet (Q. W. Report for 1873, Part III., p. 44), calls also for revision.

In all the Reports issued by the Office it will be observed that no monthly mean temperatures for the telegraphic stations have yet been published by the Committee. With reference to these stations, Mr. Symons, in December 1869, remarked: "Various facts brought under our notice convince us that more remains to be done than has yet been effected, and that in many respects these stations [telegraphic] are unworthy of the nation of which they are to a certain extent representative."† We have no means of knowing how far matters have been rectified. It may therefore be doubted, if the Office were asked to furnish meteorological information for the use of the Registrar-General, whether they possess in their own stations the means of supplying it.

We deeply regret the position we have been forced to assume in reviewing the work of the Meteorological Office, but our duty as public journalists leaves us no choice in drawing attention to the work done in return for the annual grant by Parliament of 10,000*l.*

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* Journal Scot. Met. Soc., vol. iii. p. 290.

† *Meteorological Magazine*, vol. iv. p. 177.

ARCTIC GEOGRAPHY AND ETHNOLOGY

A Selection of Papers on Arctic Geography and Ethnology, reprinted and presented to the Arctic Expedition of 1875, by the President, Council, and Fellows of the Royal Geographical Society. (London: John Murray, 1875.)

WHILE in absolute value the Admiralty Arctic Manual must be regarded as considerably superior to the one before us, still the latter contains a great deal of matter interesting in itself and of high value as adding to our knowledge of the Arctic regions. The Geographical Society deserves thanks for the present it has made to the Arctic Expedition, and we have no doubt that the explorers will find the Selection of real service in enabling them to add to our knowledge in the directions pointed out therein. The editing of the work has been well done by Mr. Clements R. Markham.

The papers in the Geographical Society's "Collection" are arranged under the two main divisions of Geography and Ethnology, although under the former there is much that might be more properly classed under the head of Geology. The first series of papers in the geographical section, occupying about one-half of the space allotted to that section, and about one-fourth of the entire volume, is by Dr. Robert Brown. These papers consist mostly of reprints and condensations of papers by Dr. Brown, which have already appeared in various scientific publications. It seems to us that the value of these papers would have been much enhanced had the author carried condensation much further than he has done. Dr. Brown's style is often painfully slipshod; he frequently indulges in a great waste of words with inadequate result, and it would only have been courteous to those for whose behoof this compilation was made to have revised his papers most thoroughly, stating all the facts as briefly and clearly as possible.

It is unnecessary to enter here in detail into the subjects treated of by Dr. Brown, especially as most of the geological facts have recently been given in NATURE in the series of papers by Mr. De Rance (vol. xi. p. 447, *et seq.*) After describing all that is at present known of the Greenland coast-line, both east and west, Dr. Brown gives a brief account of the few journeys that have been attempted into the interior of Greenland. The country has never hitherto been crossed; if judiciously gone about the feat might very possibly be accomplished. He believes Greenland to be "only a circlet of islands separated from one another by deep fjords or straits, and bound together on the landward side by the great ice-covering which overlies the whole interior, and which is pouring its outflow into the sea in the shape of glaciers and icebergs." The general opinion undoubtedly is, as one of the greatest glacial authorities, Mr. James Geikie, puts it, that "the whole interior of the country would appear to be buried underneath a great depth of snow and ice, which levels up the valleys and sweeps over the hills," though Dr. Brown believes there are no mountains of any extent in the interior. The statement of Dr. Rink, in his paper, reprinted here, "On the Discoveries of Dr. E. K. Kane," seems to us, however, to be more philosophical. "The reality is," Dr. Rink says, "that wherever one attempts to proceed up the fjords of Greenland, the interior appears covered with ice; but there is no reason whatever to assume that this applies to the central part of the country, in which one, on the contrary, just as well may assume that there are high mountain chains, which protrude partly from the ice." Dr. Rink, moreover, thinks the "ice-fjords point out probably the rivers of the original land, now buried under ice." At present any statements with regard to the interior condition of Greenland must be at best conjectural, though all we know seems to point to its being one sheet of glacial ice, the main flow of the glacier being to the west rather than to the east.

The remainder of the geographical section is occupied by some very valuable papers which the Society have done well to reprint and put in the hands of the members of the Expedition. The paper "On the best means of reaching the Pole," by Admiral Baron von Wrangell, is interesting as being the first proposal to attempt to reach the Pole by the route of Smith's Sound. The paper, moreover, gives some valuable hints as to the method which ought to be adopted in attempting an exploration by this route, and coming as they do from one who has had so great experience in Arctic exploration, they ought to be received with great respect. The paper by Dr. Rink, who may safely be entitled "one of the most eminent living authorities" on many scientific subjects connected with Greenland, on the discoveries of Dr. Kane, we have already alluded to. While admitting the valuable contributions made by Dr. Kane to our knowledge of the geography of the Smith Sound route, Dr. Rink justly criticises the scientific theories broached by Dr. Kane as to the interior of Greenland, the "open Polar Sea," the connection between the Greenland and American coasts, and other points. Dr. Kane's theories are shown to have been based on very insufficient data, and subsequent exploration has only served to prove the justness of Dr. Rink's criticisms.

One of the most careful papers in this section is by Admiral E. Irminger, of the Danish Navy, on "The Arctic Current around Greenland." This paper is based on a thorough examination of the log-books of a large number of Danish ships sailing between Greenland and Denmark. The now generally accepted conclusion he reaches is that the current from the ocean around Spitzbergen, which carries so considerable masses of ice, after it has passed along the east coast of Greenland, turns westward and northward around Cape Farewell, *without detaching any branch* to the south-westward, directly towards the banks of Newfoundland. The current afterwards runs northward along the S.W. coast of Greenland, until about lat. 64° N., and at times even as far up as 67°. Afterwards turning westwards, it unites with the current coming from Baffin's and Hudson's Bays, running to the southward on the western side of Davis Strait, along the coast of Labrador, thus increasing the enormous quantity of ice that is poured into the Atlantic Ocean.

The concluding series of papersin the geographical section is by Admiral Collinson. "The full results of that distinguished officer's remarkable Arctic voyage," to quote the words of the preface, "have never been given to the public; and both the Fellows of the Society and the officers of the Arctic Expedition are to be congratulated on having elicited so valuable an instalment. Admiral Collinson gives his notes on the state of the ice, and on indications of open water, from the mouth of the Siberian river Kolyma, along the shores of Arctic America, to Bellot Strait. He also furnishes a narrative of all the expeditions that have explored the shores of Arctic America, from Point Barrow to the Mackenzie River, and from the Mackenzie to the Back River, including his own voyage, and concludes with some general observations on the ice." The contribution made by Admiral Collinson is really an elaborate one, and must have cost its author much trouble. It affords insight into a variety of points connected with Arctic navigation, but more especially on the tides, the nature of the ice, the set and rate of the currents in Behring Strait, and to the east and west of that along the coasts of America and Asia.

"On the Asiatic side we have indisputable records of open water continuously met with during the period of lowest temperature for a distance of upwards of 1,000 miles. On the opposite shore the ice is driven frequently during the winter by the force of the wind from the coast at Point Barrow, but along the American continent to the eastward the ice, as far as we are capable of judging from one winter's experience, it remains quiet and immovable. Hence comes the question, Does the effect of the Pacific current lose itself in the expanse of the Polar Sea, or does it take an easterly trend? So far as experience guides us, the positions reached by the *Enterprise* in 1850 prove the existence of a loose pack 100 miles to the north-east of Point Barrow; beyond this, until we come to the records given by Sir R. M'Clure, nothing is known, but we have undoubted testimony that the pressure on the north face of Banks Land comes from the westward: and here in this strait, between Melville Island and Banks Land, occurs one of those dead locks in the motion of the ice that are remarkably instructive. . . . . So far as can be gathered from the accounts given, it may, I think, be assumed that the pack is looser, and open spaces of water are more frequent to the north than they are to the south of the Parry Group. . . . Though the Pacific current is in a great measure turned aside from the face of the American continent by the abrupt change in the direction of the coast at Point Barrow, the testimony of all navigators is conclusive that it is felt, and that an easterly set pervades to a greater extent than a westerly one, and that this set is more noticeable to the east of the Mackenzie."

All the papers in the second part of the Selection, that on Ethnology, are valuable. Mr C. R. Markham contributes four papers, the first "On the Origin and Migration of the Greenland Eskimo," being one of the most interesting and instructive in the whole book. Mr. Markham has evidently given the subject careful study, and his hypotheses seem to us to be on the whole sound. For three centuries after the Norse began to settle in Greenland in the end of the tenth century, Mr. Markham believes that no indigenous race was seen in the land; that all at once, about the middle of the fourteenth century, a horde of Skrœllings appeared in the extreme northern frontier settlements of Greenland, and seem rapidly to have stamped out the Norse colonists. Whether this was so or not, there seem to us great probability in the theory of the migration of the Greenland Esquimaux advanced by Mr. Markham. During the centuries preceding the first reported appearance of the Esquimaux in Greenland, the commotions in Central Asia, under Tugrul Beg, Jenghiz Khan, and other leaders, were the means of sending forth swarms of Turks and

Mongols in all directions. The pressure caused by these invading waves on the tribes of Northern Siberia drove them still further to the north. Horde succeeding horde increased the pressure, until at last the Omoki, the Chelaki, the Onkilon, and other aboriginal tribes, were driven quite out of the country, and have long ago disappeared entirely, leaving only traditions of their existence and remains here and there of their *yourts* or dwellings.

Mr. Markham thinks that here we have probably the commencement of the exodus of the Greenland Esquimaux, which spread over a period of one or two centuries. He believes they must have made their way from Cape Chelagskoi to the Parry group, probably over a chain of islands. Still keeping northwards, by Banks Island, Melville Island, Bathurst Island, North Somerset and Devon, Jones' Sound, Carey Islands, on all which undoubted traces of Esquimaux have been found, but where the conditions are not favourable to permanent settlement, the Asiatic emigrants made their way to Smith Sound, which they crossed in parties during the fourteenth, fifteenth, and sixteenth centuries. Some established their hunting grounds between the Humboldt and Melville Bay glaciers, and became the ancestors of that very curious and interesting race of men the Arctic Highlanders. Here the vegetation, the constant open water, and other conditions rendered a permanent settlement possible. Mr. Markham believes that some of these immigrants proceeded southwards and peopled South Greenland; not only so, but that parties also wandered still further north than the Humboldt Glacier, and that it is not improbable that our new Expedition may find groups of Esquimaux up to the very Pole itself. *Nous verrons.* Meantime, we repeat, Mr. Markham's theory seems to us a plausible one, and to answer all the requirements of an immigration into Greenland of a people such as are the Esquimaux. Dr. Rink, however, in a paper on the Descent of the Esquimaux, is inclined to believe them the last wave of an aboriginal American population driven from the interior by the pressure of tribes behind them. This may have been so, and the people in the north-east of Siberia, so strongly resembling the Esquimaux in language, *physique*, and customs, may have been American emigrants; but the reverse hypothesis appears to us much more probable.

Another extremely interesting paper by Mr. Markham, on the Arctic Highlanders, contains many details concerning the country, the character, the manners, customs, language, &c., of this curious people. Mr. Markham remarks upon what has been noticed by several explorers, the wonderful talent of this people for topography, and reproduces a most careful and accurate chart of the Greenland Coast from Cape York to Smith Channel, drawn by the Greenlander Erasmus York. These two papers are well worthy the attention, not only of the explorers for whom they have been compiled, but of all interested in Greenland ethnography. Mr. Markham's other contributions are a sketch of the grammar of the Esquimaux language, with copious vocabularies, and a long list of the names of all places on the coast of Greenland from lat. 65° 15′ N. on the eastern side, round Cape Farewell, to the entrance of Smith Sound. Along with this most laborious list is a chart of the south coast of Greenland from the Danish Admiralty Survey, with Mr. R. H. Major's adaptation of the ancient sites in the East Bygd, of the old Greenland colony.

Dr. Rink's paper on the Descent of the Esquimaux we have already referred to, and we have space merely to allude to the admirable and interesting and almost exhaustive paper on the Western Esquimaux, by Dr. John Simpson, of H.M.S. *Plover*, reprinted from the Parliamentary Arctic Papers of 1855. The volume concludes with the Report of the Anthropological Institute, and an appendix containing ethnological questions for explorers, drawn up by various eminent members of that Society,

Altogether, from the brief glance we have been able to take at this "Selection," it will be seen that it contains much of really intrinsic value, for having put which into so accessible a form, all who take an interest in Arctic matters will be grateful to the Geographical Society. It will, we are sure, moreover, be a welcome addition to the equipment of the members of the Arctic Expedition; and if carefully studied, as no doubt it will be, it cannot but suggest many lines of inquiry that are likely to lead to very valuable results.

VOGEL'S "LIGHT AND PHOTOGRAPHY"

The Chemistry of Light and Photography in its Application to Art, Science, and Industry. By Dr. Hermann Vogel, Professor in the Royal Industrial Academy of Berlin. With 100 Illustrations. (London: Henry S. King and Co., 1875.)

TO one acquainted with the very small amount of scientific literature yearly produced by the professional and amateur devotees of photography the name of Dr. Hermann Vogel is one associated most intimately with the scientific progress of the art. Dr. Vogel has lately attracted somewhat wider notice by his researches on the effects of coloured media in modifying the action of monochromatic light on photographic films, and the research is likely to lead to important results in the department of spectrum photography.

It was therefore in anticipation of at last finding a scientific manual of photography that we took up the translation of Dr. Vogel's work at present under review, hoping that Messrs. King and Co. had been the means of bringing a good book before the English scientific and photographic world. Unfortunately the whole experiment has been spoiled by the simple device of placing the translation in the hands of a person who is totally unacquainted with either chemistry or photography, and who is also not given to expressing himself in clear English.

On p. 4 we are informed that argentic chloride can be prepared by "directing chloric gas upon metallic silver;" and on p. 19 that "by employing *iodide of bromium* . . . the process of exposure was made a matter of seconds." On p. 35, "Archer coated glass plates with collodion in which salts of iodide had been dissolved;" and the same page contains this typical specimen of English: "After 1853 paper pictures on collodion negatives came more and more into vogue, the demands for daguerreotypes fell off and soon vanished altogether, and were produced only here and there in America;" while on p. 36 we are told that there are in Berlin "ten photographic album manufactories, to satisfy the demand, from whence they are exported to all parts of the world."

The following explanation of the reaction occurring during the immersion of the collodionised plate in the nitrate bath is given at p. 41: "The salts of iodine and of bromine that exist in the collodion film change their *properties* with nitrate of silver and give birth to iodide and bromide of silver and to *nitric acid salts*." The italics are our own. On p. 70 a footnote is added to explain that "1 gramme = the 1,000th part of a cubic metre, about nine solid feet of water at the ordinary average temperature."

Under the head of "Operation of Light on the Elements," which commences on p. 107, we find that chlorine is "a greenish strong-smelling gas developed from chloride of lime," that bromine "is an unpleasantly smelling substance of a fluid nature," and that iodine is "a black substance also of a fluid nature and used for friction." "Sulphur unites with oxygen and produces the pungent strong-smelling sulphuric acid;" "chloride and bromide gas show a peculiar relation to light even in their combinations;" and lastly, iodine again appears as a "solid body appearing in the form of shining black crystals, and emitting, when heated, a wonderful violet vapour."

Under the head of "Chemical Effects of Light on Salts of Silver," chloride of silver forms a "cheesy" precipitate; chloride, bromide, and iodide of silver are "very tenacious bodies;" when chloride of silver is exposed to light, the "chloride is liberated, and disappears as a greenish gas, which, from its abundance as well as its odour, can be perceived to be chloride of silver." "Green vitriol is greatly attracted by oxygen, and taking it up readily, passes into sulphate of iron."

On p. 118 we have the following lucid description of the toning process:—"The positive prints are subjected to a further treatment styled the colouring process. To this end it is plunged in a very diluted solution of gold. This solute (*sic*) contains chloride of gold. Metal silver has more affinity with chlorine than gold; hence it combines with the chlorine, forming chloride of silver, while the gold is precipitated. It becomes separated in the shape of a blue colour, adhering to the outlines of the picture, and this blue, mixed with the brown of the picture, gives a pleasant tone which does not change in the fixing-bath, that is, in hyposulphite of soda." The latter body is, by the way, alluded to indifferently as hyposulphite of soda, "fixing sodium," and "fixing natrium."

In photographic apparatus the translator is equally at sea. A dark slide is continually spoken of as a "cassette," and a printing frame as a "copper frame." The technical names of the processes are also as a rule incorrect.

We have no patience to devote more time to this wretched translation, which is only passable in portions of the part on the physics of some of the photographic processes.

While Dr. Vogel is held to blame for a prolixity and discursiveness which, together with the childishly elementary character of much of the work, render it very dull, the editors of the "International Scientific Series" must be held responsible for still further reducing the value of the work by employing a translator ignorant of the subject.

R. J. F.

OUR BOOK SHELF

Ornithological Miscellany. By George Dawson Rowley, M.A., F.Z.S., Member of the British Ornithologists' Union. Part I., No. I. January 1875. (London: Trübner and Co.)

THE first number of Mr. Rowley's "Ornithological Miscellany" is devoted to the illustration of some of the rarer birds of New Zealand which have lately come into his collection. The most interesting of these is perhaps the large spotted Apteryx discovered by Mr. Potts in 1873, and named after Dr. Haast, of which, we believe, Mr. Rowley's specimens are the first that have reached this country. Figures of and remarks on the other known species of Kiwi are also given, so that we have altogether a nearly complete account of what has yet been ascertained respecting the external form and habits of these singular birds. Mr. Rowley passes on to discuss the structure of the feathers of the Struthious birds, of which he also gives us some admirable illustrations. A glance at these will serve to show how very far removed in many essential points is the genus *Apteryx* from the Cassowaries and others of the order *Struthiones*, with which it is commonly associated. Finally, Mr. Rowley gives us an account of a white variety of one of the Nestor parrots of New Zealand, which, as all birds are subject to the occasional influences that produce albinism, is not, perhaps, after all, of special interest; but Mr. Keuleman's well-drawn figure of this bird will be appreciated by all ornithologists.

Such are the contents of Mr. Rowley's first number. In regretting that he does not know when the next will appear, or what it will contain, we fully sympathise with the author. But if Mr. Rowley can produce from his cabinets a similar series of rarities to figure, and find an equally good artist to draw them, we are sure that his second and following numbers will meet with equal appreciation from every lover of natural history.

On Numerals in American Indian Languages, and the Indian Mode of Counting. By J. Hammond Trumbull, LL.D. (Hartford, Connecticut, 1875.)

FROM a careful examination of the numerals in various North American languages, Dr. Trumbull adds some interesting evidence to that already available as to the native development of arithmetic among uncultured races. The derivation of numeral-words from the names of the fingers habitually used in counting numbers is well shown in Hudson's Bay; Esquimaux *eerkitkoka* = "little finger" being used as a numeral for 10, while *mikkeelukkamoot* = "fourth finger" signifies 9. Other materialistic sources of numeral-words are apparent in the Micmac language, where *tabu* = "equal" has become a numeral for 2 (like our own word "pair," from Latin *par*), while *tchicht*, which means 3, may have originally meant "more" or "again," and been used to distinguish the plural as beyond the mere dual (compare Latin *trans* and *tres*). As in the civilised Old World languages with which philologists especially occupy themselves, the numerals have for the most part lost the traces of their original significance, their development, a not unimportant part of the intellectual development of mankind, has to be learnt from investigations like the present into savage or barbarian tongues.

E. B. T.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

British Rainfall, 1874

I AM much obliged by your favourable mention (NATURE, vol. xii. p. 76) of my annual volume, and am very glad to find that it concludes with a suggestion, because, to quote from p. 138 of the work under notice, "We always receive with pleasure suggestions for the improvement of this publication, and within reasonable limits never allow either trouble or cost to prevent the adoption of all which in any way commend themselves to our judgment."

Your suggestion is as follows:—

"The publication of the monthly as well as the annual amounts of rain for the whole of the 1,700 stations is very desirable, and it is hoped that in an early issue of the 'British Rainfall' it will be done."

I shall be glad if you will allow me to supplement the data which were before you when the above paragraph was written by some other facts, and to learn from your pages whether or not this fuller information induces any modification of your views.

As I (whether fortunately or unfortunately I need not say) have to pay my own printer's bills, I always keep them as low as possible; hence, the publication being an annual one, statements made in one volume are rarely repeated in the next. Therefore, probably, your reviewer was not aware of the principles upon which the tables of monthly rainfall (pp. 140–145) are compiled, viz., to give one station in every county in the British Isles, and two in a few of the larger ones, such as York, Inverness, and Ross. I may add *en passant* that these tables give the monthly fall at 108 stations, while the Registrar-General of England is satisfied with forty-four, and of Scotland with fifty-five; so that my table exceeds both together. That, however, is of little moment. [For your own information, I enclose a map with these 108 stations plotted.]

In the next place, I must refer to "British Rainfall, 1871," pp. 135–138, where the question of publishing additional monthly returns is discussed at length, and the method of computing the monthly fall from the percentage tables (which are given every year) is explained and illustrated by a completely worked-out example.

To this let me add that returns from 150 other stations are published monthly in my *Meteorological Magazine*, and that up to the present time another very large series (143) has been printed biennially in the Reports of the British Association.

If it is the opinion of yourself and of others competent to judge that still more is necessary, more shall be done; but it must be borne in mind that the accurate (and without accuracy figures are worse than useless) printing of 20,400 values involves a great expenditure both of time and of money. I do not quite know whence either the one or the other is to be obtained.

G. J. SYMONS

[It was just because of the inadequacy of one station in each county of the British Isles, and two in the larger counties, to represent the rainfall, even though these be supplemented by Mr. Glaisher's forty-four stations, the Scottish Meteorological Society's two hundred odd, and by Mr. Symons himself in his Magazine and in the British Association Reports, that we stated it to be very desirable that the monthly as well as the annual amounts of rain for the whole of the 1,700 stations were published. The method of computing the monthly fall from the percentage tables referred to in "British Rainfall, 1871," pp. 135-138, does not supply what is desiderated. It is the capriciousness of the distribution of the rainfall and its important bearings on many practical questions which render so desirable a knowledge of the actual monthly amounts in particular localities. Since what is desired would be an invaluable contribution to British Meteorology, we earnestly hope that Mr. Symons will be induced to supply it, and that in that case he will receive substantial support in carrying on a work so important.]

Equilibrium of Temperature in a Vertical Column of Gas

I OBSERVE that Mr. R. C. Nichols, in his letter to NATURE (vol. xii. p. 67), admits that the mean energy of molecules "*may*" remain the same at all points of a vertical column. It is not difficult to show that it *must* do so if the velocities are distributed among the molecules according to the exponential law.

As I have never seen any direct proof of this in English I extract the following from Boltzmann.

In order not to take up too much of your space, we will take the simplest case, and suppose the molecules to be equal elastic spheres, moving in a vertical tube with elastic base and sides. Let them be acted upon by vertical forces, the potential of which at height x above the base is $f(x)$. Assume first that no encounters take place between the molecules, and let the number of molecules at the base, the energy of whose vertical velocity is v^2, be $C\epsilon^{-\frac{v^2}{k^2}}$ where C and k are constants. For each molecule the sum of the potential and kinetic energies is constant.

And as the horizontal velocities are constant, it follows that for each molecule the sum of the potential energy and the energy of vertical velocity is constant. That is, the energy of vertical velocity is diminished by $f(x)$ in the ascent from the base to x.

Therefore the molecules which at height x have u^2 for energy of vertical velocity are the same identical molecules which at the base have $u^2 + f(x)$ for energy of vertical velocity.

Their number is therefore $C\epsilon^{-\frac{u^2+f(x)}{k^2}}$ that is $\epsilon^{-\frac{f(x)}{k^2}} C\epsilon^{-\frac{u^2}{k^2}}$.

Therefore the number of each class at x is the same as the number of the same class at the base multiplied by the factor $\epsilon^{-\frac{f(x)}{k^2}}$.

Evidently the mean energy is the same at all points of the tube, and the density only varies, and is represented by $\epsilon^{-\frac{f(x)}{k^2}}$.

Again, still precluding encounters, let the velocities of the molecules in each of two horizontal directions at right angles to each other be distributed according to the same law as the vertical. And further, let the chance of a molecule having given horizontal velocity in either direction be independent of its velocity in the other horizontal direction or in the vertical. The same distribution and independence will be maintained throughout the tube. And we see that force has no tendency to disturb it.

Maxwell has shown that among such molecules as we have supposed encounters have no tendency to disturb the given distribution, which must therefore remain undisturbed though force and encounters both be present.

S. H. BURBURY

Primine and Secundine

WILL you allow me to avail myself of your pages as a means of pointing out to those who have purchased the English edition of "Sachs's Text-book of Botany" an unfortunate error which Prof. Oliver has been so good as to point out to me?

On p. 501 the inner coat of the ovule is identified with the "Primine" of Mirbel, and the outer with the "Secundine." The application of these terms is exactly inverted. The confusion easily arises from the fact that the secundine is developed *first* and the primine *second*. Mirbel, however, ignorant of, or disregarding that fact, numbered his structures from without inwards. The outer coat he termed the primine, the inner the secundine, the nucleus the tercine, and so on to quartine and quintine.

Except for the sake of accuracy the matter is of no essential consequence. Those who study the coats of ovules may well be indifferent to Mirbel's perplexing terms. But in these days, when students are expected for examination purposes to know about the names of things rather than about things themselves, it might lead to deplorable consequences, of which I hasten to relieve myself of the responsibility.

W. T. THISELTON DYER

American Indian Weapons

IN Col. Lane Fox's Catalogue of his Anthropological Collection he quotes Schoolcraft as saying, "There is no instance amongst the North American Indians in which the war-club employed by them is made of a straight piece, or has not a curved head." I send you a drawing (Fig. 1) of a club in common use among the Numas, or Indians of the Great Interior Basin, embracing Shoshones, Utes, Pueblos, &c., which will no doubt interest Col. Fox and others, not only on account of its extreme simplicity of form, but also of its method of use. It might be called appropriately a "face-masker," being grasped with the bulb next to the little finger, and thrust into the countenance of the foe. Major Powell sent a number of these to the Smithsonian Institution. They are of one piece of wood, generally mezquite, either very rude or quite smoothly polished, and are worn attached to the wrist by a leather thong. They vary in length from eight inches to fourteen. These same tribes use a simpler "slung shot" than the one described in Col. Fox's Catalogue, p. 65 (Fig. 2), the stone ball hanging loosely from the handle in a bag of buckskin. The Moquis of this same region use the boomerang; two of these (Fig. 3) are in the Smithsonian Institution. I am not sure that it returns to the hand of the thrower.

On page 91 of Col. Fox's Catalogue he says: "In California and the greater part of the North American Continent the arrows are constructed either in a single piece or with a bone foreshaft; but in no case have I come across a foreshaft of hard wood." Among the Numas of the Great Basin, reed arrows with hard wood foreshaft are very common (Fig. 4). In Northern California two kinds of arrows have hard wood foreshaft, those with and those without stone points (Figs. 5 and 6). The stripes on the feather end are rancheria marks, and the foreshaft is moveable. **Otis T. Mason**

Washington, D.C., U.S., May 19

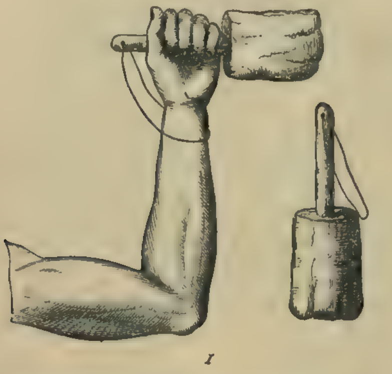

Fig. 1.—Pai-Ute War Club, for thrusting by a backhanded blow into the face of an enemy. Made from the wood of the Mezquite bean.

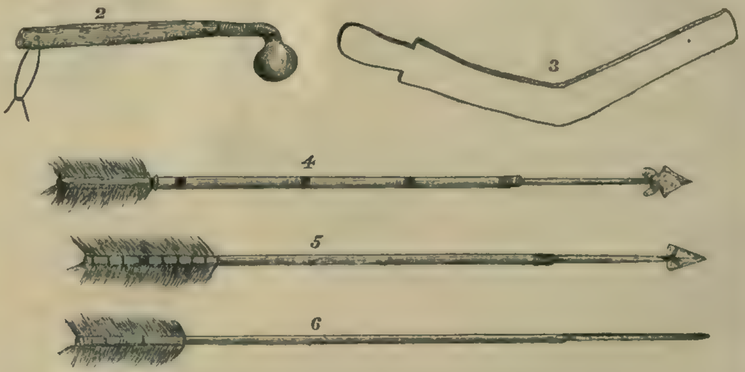

Fig. 2.—Pai-Ute War Club. Fig. 3.—Moquis Boomerang. Fig. 4.—Numa Reed Arrow, with hard wood foreshaft. Fig. 5.—Klamath River Pointed Arrow; soft wood shaft, hard wood foreshaft. Fig. 6.—Klamath River Arrow, without point; soft wood shaft, hard wood foreshaft sharpened.

Primroses and Cowslips

Mr. Fordham (Nature, vol. xii. p. 87) is quite right in conjecturing that it may be without foundation he has thought that primroses are not found in districts in which cowslips are common, and *vice versâ*. In the north-east of Staffordshire, for miles round Denstone College, early in the spring, nearly all the hedges and many of the fields are covered with primroses. Later on cowslips abound; I might add that oxlips are also far from being rare.

I have watched closely, but have never found a trace of any destruction of the flower by birds. This, perhaps, may be accounted for by the fact that this being a pasture country, the sparrow, finding no grain, is a *rara avis* about here. I have noticed in Lord Bagot's wood, some twelve miles from here, where sparrows as well as many other birds are found in great numbers, that the primroses nearly always present a very ragged appearance. **D. Edwardes**

Denstone College, Uttoxeter

I could name half a dozen spots to the north of London (Mill Hill) where cowslips and primroses have abounded together in the same meadow, to my own knowledge, for the past twenty years. For at least five years I can say that neither the primroses nor cowslips were attacked by birds, though the crocuses were cut up by them more or less every season in the same locality. **R. A. N.**

THE VISITATIONS OF GREENWICH AND EDINBURGH OBSERVATORIES

We have before us the Annual Reports of the Astronomers Royal for England and Scotland, to their respective Boards of Visitors. The Report of Sir G. B. Airy consists mainly of the usual statements under the various heads of the state of the buildings and instruments, the constitution of the staff, and the amount of work done. In all these respects the Observatory seems to be in a satisfactory condition. One important change in the staff during the past year has been the resignation of Mr. Glaisher, who has for so many years been connected with the Observatory, and which has rendered necessary a readjustment of the duties of the various observers.

Under the head of "Chronometers, Time-signals," &c., the Astronomer Royal refers to the supplemental mechanism which he himself has introduced into some chronometers in order to correct the perceptible defect of thermal compensation which occurs in nearly every case, even in the best chronometers. "There is," he states, "great difficulty in correcting the residual fault, not only because an inconceivably small movement of the weight on the balance-curve is required, but also because it endangers the equilibrium of the balance. To remedy this I have introduced small supplementary weights carried by means of a supplementary bar (rotating with stiff friction in the balance-staff), at whose ends are very light springs carrying the supplementary weights, and constantly pressing them to the interior of the balance-curve. When the supplementary bar is so turned that the supplementary weights are near the end of the balance-curve, the compensation is large; when they are near the root of the balance-curve, it is small. The movement from one state to the other is so simple that probably an assistant of the Observatory will be able to manage it, and it does not interfere with equilibrium. This arrangement has received the approval of some able chronometer-makers, and may perhaps with advantage be adopted generally."

The various time-signals and clocks connected with the Observatory have been worked with praiseworthy regularity and accuracy; the Westminster clock has been so well regulated, under check of automatic report to the Observatory, that in 83 per cent. of the days of the year its error is below one second. Proposals have been made for galvanic determination of the longitude of the Dublin Observatory, and the operation is delayed only for convenience in the arrangements to be made at Dublin. With the aid of a grant from the Treasury three computers are now steadily at work on the Astronomer Royal's New Lunar Theory.

The most novel and interesting part of Sir George Airy's Report is his concluding "General Remarks," in which he takes a rapid glance over the changes in the Observatory in the forty years during which he has been at its head. "The Observatory was expressly built," he states, "for the aid of astronomy and navigation, for promoting methods of determining longitude at sea, and (as the circumstances that led to its foundation show) more especially for determination of the moon's motions. All these imply, as their first step, the formation of accurate catalogues of stars, and the determination of the fundamental elements of the solar system. These objects have been steadily pursued from the foundation of the Observatory; in one way, by Flamsteed; in another way, by Halley, and by Bradley in the earlier part of his career; in a third form, by Bradley in his later years, by Maskelyne (who contributed most powerfully both to lunar and to chronometric nautical astronomy), and for a time by Pond; then with improved instruments by Pond, and by myself for some years; and, subsequently, with the instruments now in use. It has been invariably my own intention to maintain the principles of the long-established system in perfect integrity; varying the instruments, the modes of employing them, and the modes of utilising the observations by calculation and publication, as the progress of science might seem to require.

"While instruments of the same class, but of increased power, have been substituted for those which I found here, three novel constructions have been introduced; the lunar altazimuth, the reflex-zenith-tube, and the chronograph; and, for a special investigation, the water-telescope (now dismounted). I omit mention of auxiliary instruments. To utilise the observations, the numerical reductions for each current year have always been maintained in the most perfect state that I could devise. From these, elaborate star-catalogues (now in frequent demand) have been formed from time to time. And, for connecting the observations of the moveable bodies of our system in a complete and homogeneous series, beginning at 1750, first the planetary observations, and secondly the lunar observations of my predecessors have been reduced, and orbital elements have been corrected. The lunar reductions are probably the greatest single work ever undertaken in astronomy. This portion of our labours may be considered as applying to the combined subjects of astronomy and navigation. But there are also, peculiar to astronomy, the photoheliography and spectroscopy lately introduced. And, peculiar to navigation and related subjects, there are the investigation of the laws of magnetic disturbance in iron ships, and the correction of the compass by methods now used in the commercial navies through the world; the maintenance of magnetic observations; the incessant attention to chronometers; the extensive dissemination of accurate time-signals; and the daily dropping of a time-ball at Deal.

"The subject of meteorology, which has been followed for many years, is scarcely connected with the two great heads of astronomy and navigation, and hardly deserves the name of a science. It is, however, in great popular request. Mechanical self-registration of some meteorological phenomena was introduced by me shortly after the commencement of my residence. Since that time the practical arts of photography and galvanic communication were invented, and they were quickly made available in many of our operations. In this increase of occupations, the annual expenses of the Observatory have increased, but in a much lower proportion than the work done.

"Experiments have been made, bearing on cosmical physics, by Maskelyne for the attraction of Schehallien, and by myself for the vibrations of pendulums in mines. Preparations have been made for observations of eclipses and of the Transit of Venus. Assistance has been rendered to the Government in training officers for such services as tracing national boundaries, &c., and in reference to National Standards. The Lunar Theory, though most intimately connected with the highest interests of astronomy, scarcely presents itself to me as a work of the Observatory.

"Turning now from the past to the future, I see little in which I could suggest any change. If it should ever be necessary to make any reduction, I should propose to withdraw meteorology, photoheliography, and spectroscopy; not as unimportant in themselves, or as ill-fitted to the discipline of the Observatory, but as the least connected with the fundamental idea of our establishment. In the nature of addition, I will indicate one practical point. I much desire to see the system of time-signals extended, by clocks or daily signals, to various parts of our great cities and our dockyards, and above all by hourly signals on the Start Point, which I believe would be the greatest of all benefits to nautical chronometry. Should any extension of our scientific work ever be contemplated, I would remark that the Observatory is not the place for new physical investigations. It is well adapted for following out any which, originating with private investigators, have been reduced to laws susceptible of verification by daily observation. The National Observatory will, I trust, always remain on the site where it was first planted, and which early acquired the name of 'Flamsteed Hill.' There are some inconveniences in the position, arising principally from the limited extent of the hill, but they are, in my opinion, very far overbalanced by its advantages."

We quite agree with the Astronomer Royal that a strictly Astronomical Observatory is not the place for such observations as those mentioned in the conclusion of his Report; it would be much, both to the advantage of astronomy and of the important branches of science referred to, that the latter should have one or more Government establishments allotted solely to their investigation, establishments quite distinct from and independent of the Greenwich Observatory.

The Report of the Astronomer Royal for Scotland is a little more fervid than the one just mentioned, or indeed than official documents generally are. The funds of the northern establishment continue to be extremely inadequate to its requirements, and it reflects great credit on Prof. Piazzi Smyth that he is able, year after year, to show such a satisfactory output of work.

In reference to Zodiacal Light Spectroscopy, the Report, referring to the results obtained by the expedition, at Prof. Smyth's own expense, to Sicily in 1872, states that he has another research of the same kind in progress, which will require him, for its completion, to visit successively with the same instruments the shores of the Arctic Ocean and a tropical mountain-peak. We hope Government will provide him with the very small sum necessary to carry out this important work. Prof. Smyth is also carrying out, under great difficulties, observations in Auroral Spectroscopy, for which he is very favourably located; but again he is hampered by want of the necessary instruments. No doubt Mr. Cross's recent unexpected official visit, if it meant anything at all, will lead to speedy attention being paid to the very reasonable demands of the Scottish Astronomer Royal.

An appendix to the Report contains some documents intended to show the real position of the Observatory and of its chief, and his relation to the professorship of astronomy in Edinburgh University which he holds. It seems the University Council wish to make out that 300*l.* of his not excessive salary he receives solely as occupant of that chair, and must resign this sum with the chair. Altogether it seems to us the duty of Government to make a speedy and thorough inquiry into the position of the Northern Observatory, and put it into a state of such complete efficiency that there will be no further room for complaints. We regret to see that the new equatorial is still in the contractor's hands.

THE PROGRESS OF THE TELEGRAPH *

VII.

IN 1843 Alexander Bain made certain important improvements in the recording and transmitting instrument shown in Fig. 28, in which two semicircular magnets B B′, with similar poles facing, fixed to a brass bar, move through the centres of two coils, A A′, the index-hand pointing to I or V according to the direction of the current. This was controlled by the metallic contacts N N′ N″ N‴ opening or closing the battery and line circuits according to the position of the handle F. The connection and direction of the current through the instrument from the battery D is indicated by the arrows, the connection R being that of the line wire, and S that of the earth circuit.

This patent and certain others that will be brought under notice gave rise to expensive litigation in the early history of the telegraph. In 1846 John Nott produced his letter-recording telegraph, which, in conjunction with Mr. Alexander Bain's inventions, was carried into the law courts on a question of infringement of the Cooke and Wheatstone patent rights; but for reasons already given regarding patent law, the opposition was unsuccessful on the part of the Electric Telegraph Company.

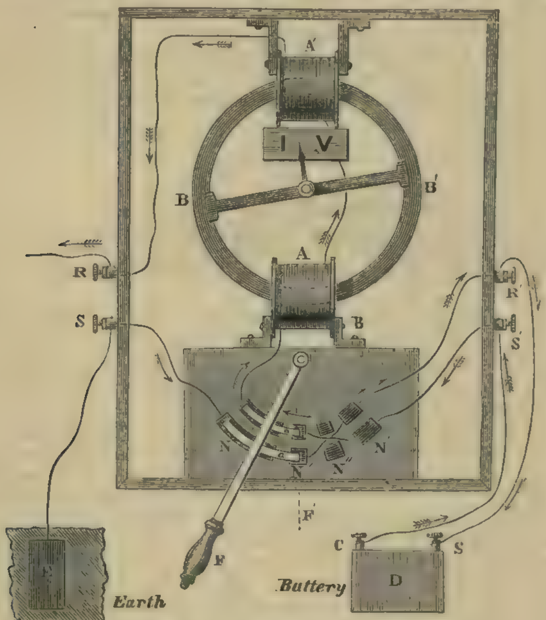

FIG. 28.—Bain's I and V telegraph, 1843.

Nott's apparatus is shown in external and internal elevation in Figs. 29 and 30. It consisted of a dial showing the letters of the alphabet and numerals repeated four times in the circumference of the circle. The respective letters or numerals were indicated by the step-by-step motion of a revolving pointer or index-hand. The motion of this pointer was controlled by successive make-and-break contacts with the battery by means of a finger-key dipping into a mercury cell, *b*. The index-pointer was driven round by a "clawker-and-driver" action in connection with the toothed wheel *c*, the propelling power being derived from the attractive and repellant action of two horseshoe electro-magnets, *a*, *d*, acting upon soft iron armatures in connection with the "clawker-and-driver" motion. The electro-magnet *b* governed the alarum or call-signal. Either the speaking or alarum portion of the telegraph was brought into action by the position of the contact drums, *f*, *f*, which regulated the direction of the battery current through the electro-magnets, by means of the index shown in the external view (Fig. 29) being moved to the one side or the other.

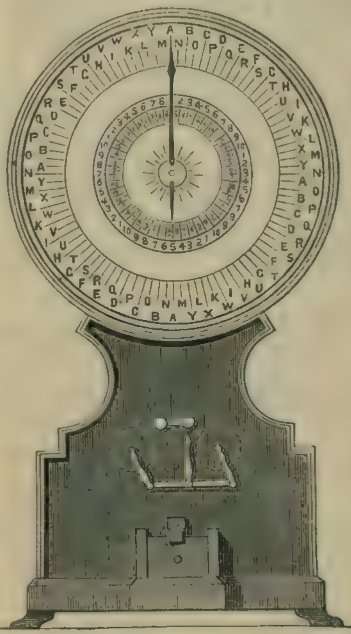

FIG. 29.—Nott and Gamble's patent, 1846. External view.

In 1846 Highton's gold leaf indicator was brought under notice, and an important automatic chemical printer-recording high-speed telegraph, by Alexander Bain, which has been the germ of several of the applications in the modern high-speed automatic arrangements (Fig. 25). In this chemical printer, a paper strip, perforated with holes in symbolic groups to represent the several words of the message, was employed to regulate the automatic sequences of the current through the line. This paper ribbon was passed over a metal drum in circuit with the line wire, and a fine metal style in connection with one pole of the battery

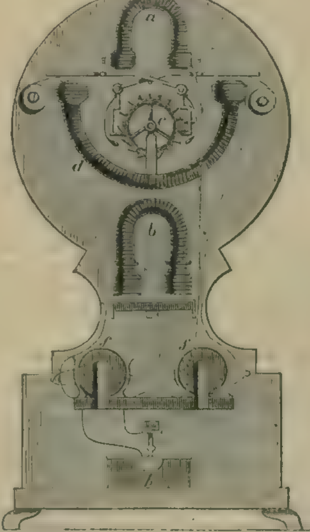

FIG. 30.—Nott and Gamble's patent, 1846. Internal arrangement.

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* Continued from p. 72.

(the other pole being to earth) pressed upon the paper ribbon. As the ribbon was drawn forward whenever a perforation passed the point of the style, metallic contact between the battery and line wire was momentarily made, and a current transmitted to the distant station, the duration of the current being regulated by the length of the perforation in the paper—thus giving the dot and dash code. The message at the distant station was printed by chemical decomposition. A ribbon of paper, prepared by immersion in a solution of sulphuric acid and prussiate of potass, was drawn over a metal cylinder in communication with the earth, and pressing upon this chemically prepared paper was a metal style in connection with the line wire. When, therefore, a current is received by reason of the metal style at the transmitting station passing a hole and joining battery to line, the chemical preparation of the receiving ribbon is momentarily decomposed by the action of this current, and a darkish blue mark will appear on the paper ribbon of a length—either a dot or a dash—corresponding to the duration of the transmitted current.

William Sykes Ward's patent, by which signals were indicated by the deflection of electro-dynamic coils over the poles of fixed permanent magnets, already noticed (Fig. 18), followed in 1847. This patent became, in common with most others, the property of the Electric Telegraph Company by purchase.

Holmes's new form of coil and needle, introduced in 1848, dispensed with the inertia of the long five-inch astatic needle combination and great coil resistances of the existing double needle system, and combined a greatly increased speed of transmission with a reduced battery power, both results of vital importance. This modification of the astatic needle combination is shown at Fig. 31, drawn to actual size, as compared with the five-inch needle.

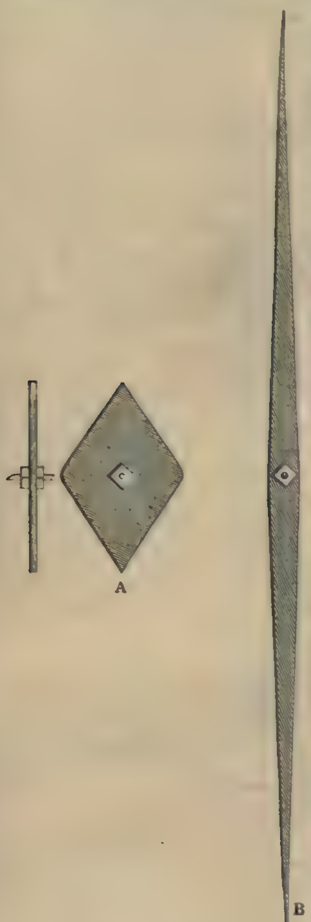

FIG. 31.—Holmes' diamond needle arrangement (A), dispensing with the astatic needle combination (B) and reducing the resistance of the coils. 1848.

The next patent brought under notice, that of Mr. W. T. Henley, led to the first serious opposition against the monopoly of the Electric Telegraph Company. In 1848 William Thomas Henley and George Foster brought out their improvements in electric telegraphs: this patent gave rise to the formation and establishment of a formidable rival in public favour to the Electric Telegraph Company, viz., the English and Irish Magnetic Telegraph Company. The improvements under this patent consisted in acting on a magnet, to the axis of which is attached an index or pointer by a single electro or other magnet, having each of its extremities converted or resolved into two or more poles. Fig. 32 shows the magnetic needle suspended between the poles of an electro-magnet, *a*, each pole being fitted with a piece of iron, of a segmental form, developing two similar poles. This magnetic needle is deflected in one direction for any length of time required by an induced magneto-current, it being brought back to its normal position by the reversed inductive current. The necessary magneto-currents to actuate the needle are produced from a magneto-electric arrangement consisting of two coils, A, A (on an armature), which are mounted on an axis, H, between the poles, M, M, of a permanent-magnet, and free to move in front of those poles upon depression of the handle, G, in such a manner that one pole of the magnet is not released from its opposition to the armature until the other just touches it, by which means currents of equal power and in opposite directions are produced. This arrangement of parts is shown in Fig. 33. These several representative improvements, selected out of the vast numbers that crowd the field up to 1848, will be sufficient for the purpose of tracing the Progress of the Telegraph.

Such were some of the instruments already invented when electrical communication was inaugurated in this country by the Electric Telegraph Company.

Proceeding down the *cul de sac* known as Founders Court, Lothbury, a stone façade, with the words "Central Telegraph Station" sculptured in bold letters, and massive oak doors, arrested the attention of the visitor. On entering, a noble and lofty hall with an enriched glass roof presented itself to view, with two long counters, one on either side, for the receipt and payment of messages. Behind these counters glass screens were placed with the names of the several stations open for messages painted in black letters upon them, the instrument rooms being behind the screens upon either side.

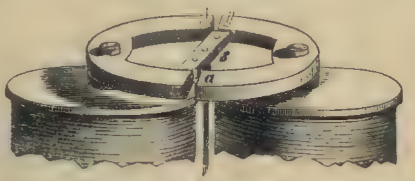

FIG. 32.—Henley and Foster's Magneto-Telegraph, 1848. Indicator movement.

The west side of the hall was devoted to correspondence with the northern and western districts, and the east side with the eastern and southern districts. Additional instrument rooms were provided on the first and second floors at the sides of the hall; and at the time of the opening of the station to the public, the Company had access to about sixty towns, with an extent of single wire along the railways of some 2,500 miles, and had a telegraph staff of fifty-seven hands appointed to the Metropolitan Station. The battery rooms, testing boxes, earth connections, and the tubes for bringing the wires into the building were situated in the basement underneath the great hall. The various wires were brought along the streets in pipes beneath the pavement. Twenty-seven came from the North Western Railway, nine from the South Western, nine from the South Eastern, nine from the Eastern Counties, nine from the branch office, 345, Strand, including those from Windsor, nine from the Admiralty, which with nine spare wires completed the circuit arrangements of the Company at the time that the telegraph was thrown open to the public. Many of the railway companies continued to reserve the use of their telegraphic lines to themselves; the Telegraph Company from the central station had therefore no power to forward public messages over such districts.

It is natural to suppose that great excitement and anxiety existed amongst the directors with reference to the opening of the building to the public for the receipt and transmission of messages. The disturbed state of

London at that time, arising from the Chartist demonstration and supposed possible attempt upon the Bank of England, by no means allayed the disquietude of the directors; as it was, most of the electrical staff had been sworn special constables, and truncheon in hand had assisted in guarding the principal buildings in the vicinity of the Bank of England and Royal Exchange. What if on the opening day a mob should rush in intent upon destroying the new-fangled invention! Such occurrences had been witnessed before. Had not Arkwright with his stocking loom, and Jacquard, incurred the fury of the ignorant artisans? Might not the rush of relatives and friends, merchants and bankers, all anxious to supersede the delays of post by the lightning speed of this new invention laid at their feet for the first time, prove so inconvenient to the clerks that all business would be interrupted, and the accuracy of the payments for messages and correctness of the transmissions be jeopardised? Besides, another evil rumour had gone abroad: light sovereigns and indifferent gold were in free circulation. Amongst all these troubles it is not to be wondered at, that as the eventful day drew near every precaution was taken to meet the assumed exigency of the occasion; sovereign scales were ordered, one for each counter already described. How could a clerk leave his place of trust to weigh a suspicious-looking piece of gold in scales situated on the opposite side of the great hall? The uniform shilling rate to all places from the metropolis did not at that time exist. Messages to Liverpool and Manchester were 8*s.* 6*d.* under twenty words, to Edinburgh 13*s.*, and to Glasgow 14*s.*; charges at that time considered very moderate, remembering the costly staff of clerks, the original outlay, wear and tear, &c. The great doors in Founder's Court were ordered to be kept fast bolted, and two port-holes cut some six inches square in the solid oak panels fitted with little screens opening inwards; so that whatever the crush in Founders Court, messages and money could be received inside through them and change given; in fact, the Central Telegraph Station was converted more or less into a fort prepared to stand a siege. The opening day came—scales on counter, change in tills, receiving and cashing clerks at their posts, every instrument and circuit along the respective railway lines proved for accuracy by the sending and receipt of test signals, staff at instruments, doors bolted. Nine o'clock strikes, port-holes opened, and, after the manner of the stage manager behind the curtain who surveys the patronage bestowed upon the boxes, stalls, and dress circle from his mysterious peephole, so did the expectant staff view the state of Founders Court through their port-holes. Not a person disfigured the symmetry of the lines of the flag pavement, save the Bank of England porter, performing his prescribed beat against the Bank wall. The sun marked midday,—afternoon,—evening,—and one paid message alone was transmitted to a station situated somewhere upon the Norwich circuit. Empty tills, idle clerks, disappointed directors. Such was the story of the opening day of the Electric Telegraph Company's Central Office. No one believed in it; it was regarded more in the light of a clever toy than a practical invention to be trusted or relied upon. This want of patronage from the public damped the ardour of some of the directors. The late Mr. Sampson Ricardo, walking into the central station the next morning, gave vent to his disappointment by declaiming on the extravagant expenditure of capital in two pairs of sovereign scales, demanding that one pair should be immediately returned to the scale-maker who had supplied the luxury.

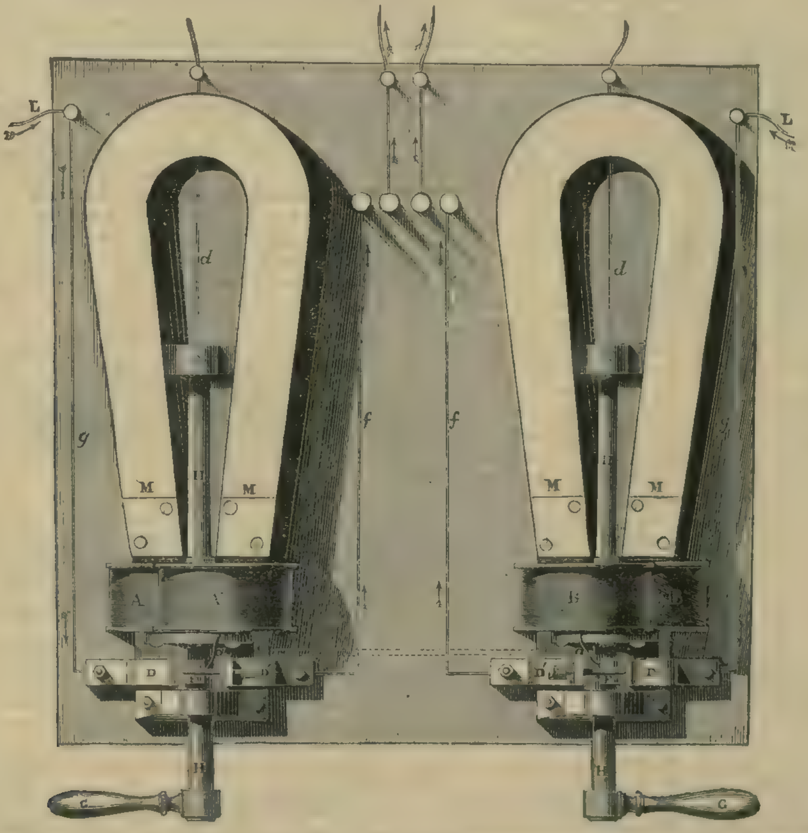

FIG. 33.—Henley and Foster's Magneto-Electric Telegraph, 1848. Plan of the magneto-coil arrangement for producing currents of equal intensity in opposite directions

After the vast expenditure of capital in the purchase of the Cooke and Wheatstone patents, erection of lines over the kingdom, station inauguration, and the incorporation of the Company by special Act of Parliament, naturally the promoters of the Electric Telegraph Company endeavoured to create a monopoly in the transmission of messages for the public.

(*To be continued.*)

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF 1886, AUG. 29.—This eclipse will be a remarkable one, on account of the length of duration of totality, which will not fall far short of that of the eclipse of 1868, Aug. 18, though it unfortunately happens that its track is mainly over the Atlantic Ocean, and there will be no land station for physical observations while the sun is hidden for the longest interval. The elements of the eclipse are, very approximately, as follows :—

Conjunction in R.A. 1886, Aug. 29, at 0h. 57m. 37·7s. G.M.T.

	°	′	″	
R.A. … … … … … … …	157	50	51·9	
Moon's hourly motion in R.A. … …		37	4·8	
Sun's „ „ … …		2	16·7	
Moon's declination … … … … …	9	10	38·4	N.
Sun's „ … … … … …	9	17	23·9	N.
Moon's hourly motion in Decl. … …		10	45·1	S.
Sun's „ „ … …		0	53·4	S.
Moon's horizontal parallax … … …		61	20·5	
Sun's „ … … …			8·8	
Moon's true semidiameter … … …		16	42·9	
Sun's „ … … …		15	51·1	

The central eclipse begins Aug. 28, at 23h. 12m. 32s. G.M.T., in longitude 79° 33′ W., and latitude 9° 51′ N., and ends Aug. 29 at 2h. 36m. 28s. in longitude 47° 19′ E., and latitude 21° 57′ S., and the sun is on the meridian centrally eclipsed in longitude 14° 13′ W., and latitude 2° 58′ N. The following are also points upon the central line :—

Longitude.	Latitude.
66° 47′ W	11° 36′ N
61 1 W	12 6 N
11 9 E	11 5 S
20 10	14 52
21 39	15 25
25 5 E	16 36 S

It would appear from this track that the only easily accessible station where the sun will be at a sufficient altitude will be at the southern extremity of the Island of Grenada, in the West Indies ; for which point, assuming its longitude 4h. 6m. 20s. W. and latitude 11° 59′ N., we find—

	H.	M.	S.	
Beginning of totality, Aug. 28, at	19	10	7	Local mean times.
Ending „ „	19	13	22	

The duration is therefore 3m. 15s., and the sun's altitude is about 20°.

If we take for a point where the sun will be near the meridian, longitude 0h. 50m. 52s. W. and latitude 2° 8′ N., we have—

	H.	M.	S.	
Beginning of totality, Aug. 29, at	0	8	48	Local mean times.
Ending „ „	0	15	14	

The duration of total eclipse, which is here nearly at its maximum, is therefore 6m. 26s., and the sun at the time is only 7° from the zenith.

From this point the length of totality diminishes, until, during the passage of central eclipse over Southern Africa from near St. Philip de Benguela to the Mozambique, it is comparatively short. It will be seen that the central line runs considerably to the north of the islands of Ascension and St. Helena.

The middle of general eclipse occurs at 0h. 54m. 30s. G.M.T. ; the sidereal time at Greenwich mean noon is 10h. 30m. 27s·8, and the equation of time 0m. 46s. subtractive from mean time, figures which may facilitate a further examination of the phenomenon.

THE SUN'S PARALLAX.—Prof. Galle, Director of the Observatory at Breslau, in a letter to M. Leverrier, gives the definitive result of his discussion of observations of the minor planet Flora (Hind, 1847, Oct. 18) in the autumn of 1873, at observatories in both hemispheres, with the view to a determination of the solar parallax. The receipt of particulars concerning some doubtful observations at Melbourne and other stations had enabled him to apply some small corrections, by which, however, the value of the sun's parallax published in No. 2,033 of the *Astronomische Nachrichten* is but very slightly changed. Prof. Galle now finds from eighty-one corresponding observations between the two hemispheres, forty-one stars of comparison to the north of the planet and forty to the south, that "the definitive result for the solar parallax should be fixed at $\pi = 8''{\cdot}873$, with a very small uncertainty in the hundredths of the second." He adds, that of ninety-six corresponding observations in all, he had excluded fifteen on account of some discordances arising from imperfections in the southern instruments, but even if these fifteen observations were included, the value is only changed to 8″·878. Prof. Galle is engaged in the composition of a memoir giving full details of his investigation. He remarks upon the close agreement of his result with that obtained by the numerous and very exact measures of the velocity of light, by M. Cornu, at the Observatory of Paris, with the theoretical determination of M. Leverrier from the perturbations of the planet Mars, and with M. Puiseux's first result from observations of the transit of Venus at Pekin and St. Paul Island. He directs attention to the circumstance, that another favourable opportunity of applying the method which has furnished a value for the sun's parallax by observations of Flora in the northern and southern hemisphere, so nearly in agreement with values deduced in other ways, will be afforded about the opposition of Eurydice (Peters, 1862, Sept. 22), which occurs on the 20th of September next, when the planet will be a bright ninth magnitude. It will be in perihelion early in the previous month, and at its nearest approach to the earth on Sept. 13, will be distant less than 0·878 of the earth's mean distance from the sun. Prof. Galle hopes to secure on this occasion the co-operation of the astronomers who have taken part in the observations of Flora.

THE MINOR PLANETS.—On comparing elements of this group as known to the present time, it appears that *Flora* has the shortest period of revolution, 1193 days, and of those which have been satisfactorily calculated, *Sylvia* has the longest, 2374 days, the corresponding mean distances, expressed in parts of the earth's mean distance from the sun, being 2·201 and 3·482. The nearest approach to the sun is made by *Phocea*, 1·787, while *Freia* recedes furthest from him, the aphelion distance being 4·002. We may add to these the following values near the extremes of distance :—

	Distance in Perihelion.
Melpomene … …	1·796
Clio … … … …	1·805
Victoria … … …	1·823
Iris and Ariadne …	1·835
Eurydice … … …	1·854
Flora … … …	1·856
Polyhymnia … …	1·890
Virginia … … …	1·899

	Distance in Aphelion.
Sylvia … … …	3·757
Cybele … … …	3·803
Pales … … …	3·810
Euphrosyne … …	3·849
Hermione … …	3·882

Polyhymnia has the greatest excentricity, 0·33998, and *Lomia* the least, 0·02176 ; *Pallas* the greatest inclination, 34° 42′, and *Massalia* the least, 0° 41′. It will be seen that the difference of distance from the sun between Phocea in perihelion and Freia in aphelion is 2·215, corresponding to about 204,000,000 miles.

M. Leverrier's *Bulletin International* of June 5 contains a telegraphic intimation from the Smithsonian Institution of the discovery of a new minor planet by Prof. Peters in R.A. 17h. 21m., and N.P.D. 113° 21′. It is as bright as stars of the eleventh magnitude, and is No. 144 of this group of planets.

[Since the above was in type we receive notice of the discovery of No. 145, by Prof. Peters, in R.A. 17^h 14^m, N.P.D. 113°·8′, apparently on June 4. Motion towards S.: twelfth magnitude.]

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*LECTURES AT THE ZOOLOGICAL GARDENS**

VI.—*Mr. Flower on Elephants.*

WITH the exception of the domesticated species few mammals are so well known to everyone as the Elephant, few are more interesting from their sagacity and usefulness to mankind, and few are so wholly separated and isolated from all other forms which now exist. Formerly the Elephants were grouped with the Rhinoceroses or with the Pigs, but a better knowledge of their structure has shown that they form an entirely distinct order, to which the name *Proboscidea* has been given, on account of the trunk, or proboscis, which is one of their most striking features. Two well-marked species of Elephant exist, the Indian (*Elephas indicus*) and the African (*E. africanus*).

The former is found in a wild state throughout the forest-lands of the greater part of India, Ceylon, Burmah, Siam, Cochin-China, the Malay Peninsula, and Sumatra, except where it has been driven back by the advance of civilisation; whether it is indigenous to any of the other islands of the Eastern Archipelago is doubtful. The Elephant of Sumatra and Ceylon has been separated by Schlegel as a distinct species, *E. sumatranus*, but Dr. Falconer and others have shown that their differences, though appreciable, do not amount to specific characters. The Indian Elephant has been domesticated from the earliest ages—in India before historic times, and also by the ancient Persians. It has been used in war, in carriage, and in state pageants, and is still much employed in road-making and bridge-building, where its strength, its sagacity, and its adroitness in piling logs, lifting weights, and similar operations, render its services invaluable.

The second species inhabits Africa, south of the Sahara, from the Indian Ocean to the Atlantic, and formerly extended its range to the Cape of Good Hope. In ancient times it was domesticated by the Carthaginians, and was the species generally imported by the Romans, but no succeeding African race has had the sagacity to make use of it. It is killed in vast numbers for the sake of its ivory, of which an enormous quantity is annually brought to Europe; and in so wasteful a fashion is this slaughter carried on, that the species will probably soon be exterminated. Although so well known to the ancients, it is only quite recently that live African elephants have been brought to Europe in modern times. There was one in Antwerp in 1863, and two years later a pair were obtained by the Zoological Society, which are still alive and well, the male having attained a height of ten feet. Since this, numbers of these animals have been imported down the Nile from the Soudan, and they are now common in menageries.

In size there is not much difference between the two species, and the maximum height would appear to be about eleven feet; an Indian elephant shot by Sir Victor Brooke reached that stature, which was not exceeded by the tallest of eleven hundred individuals measured by Dr. Falconer. In external appearance the two species are easily distinguishable. The African elephant has a lighter and more shapely head, a less protuberant forehead, and a larger eye, but its most striking peculiarity is the enormous size of its ears. It also stands proportionately higher on its legs, and has a more arched back. The number of nails is different, being four on the fore feet and three on the hind, whereas in the Indian species these feet have four and five nails respectively. Sportsmen say that the height of an elephant always equals double the circumference of the foot, and this is confirmed by the individuals now in the Gardens; in the male the proportion is absolutely correct, and in the female it is within three inches. The mental characters of the Indian and African elephants are different, the latter being bolder, quicker, and more obstinate.

In considering the general structure of the Elephants, the first peculiarity to be noticed is the trunk, which is really an enormous prolongation of the nose and upper lip. It is almost entirely composed of a complex mass of muscles which give it its great power and flexibility, and it is amply supplied with nerves. The great massiveness of the head is not owing to the size of the brain, but to huge air-cells in the body of the bones, which are an extraordinary development of the frontal sinuses. This expansion is necessary to afford room for the attachment of the great muscles which wield the head and proboscis.

The teeth of the Elephant are very peculiar. The tusks, which answer to the middle incisors of man, sometimes reach a weight of 150 lbs., or even, it is said, of 200 lbs. each. They have no enamel, being entirely composed of *ivory*—a peculiarly fine, tough, and elastic dentine—and are persistent in growth throughout life. Thus, if bullets happen to lodge in the pulp-cavity they are carried down by the growth into the tusk itself, in which they are sometimes found embedded. The molars are six in number in each side of each jaw, and are composed of alternated transverse plates of enamel, dentine, and cement. Owing to the different hardness of these materials they wear unequally, and produce cross ridges on the surface of the tooth, which form it into an admirable grindstone for crushing the food. The molars are not deciduous, but move forward in a curious way; only one (or at most a part of two) is in use at once, and each as it is worn away is pushed forwards by its successor, which eventually takes its place. The six teeth last out the life of the animal, which is said to extend to a hundred years or more. In the Asiatic species the plates of the molars are much finer and more regularly parallel than in the African elephant, in which they are fewer in number and have somewhat of a lozenge shape.

It was formerly a widespread delusion that the Elephant had no joints, and even now many people believe that their joints move in the contrary way from those of other quadrupeds. The explanation of this lies in the fact that the elbow and knee of an elephant are much nearer the ground than those of a horse or a cow, and are thus confused by a casual observer with the so-called "knee" (the true wrist) and "hock" (the true ankle) of the latter animals.

Although the Elephants are now so isolated among animals, it was not always so. They have many fossil relatives whose range once extended all over Europe (including Britain), Asia, North America, and part of South America. Of these the most generally known is the Mammoth, of which specimens have been so wonderfully preserved in the Siberian ice, and which was closely allied to the living Asiatic species. Going further back we have the Mastodon, in which the grinding teeth were much less differentiated and more like those of other animals. Beyond this it is difficult to trace their relationships. Possibly they may have been through the Dinotherium, or through some of the wonderful creatures whose remains have recently been discovered in the Eocene formations of America. But it is clear that in the Elephants we have the last remaining representatives of a mighty and once numerous race which have played their part in nature and disappeared, and it is only too probable that the survivors also are doomed to speedy extinction.

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* Continued from p. 93.

SCIENCE IN GERMANY

(*From a German Correspondent.*)

IT is not only due to the quantitative increase of scientific work, but also to the exigencies of the division of labour, that the German serials dedicated to zoological and anatomical research have been augmented by two new ones this year.

The *Morphologisches Jahrbuch*, edited by Carl Gegenbaur, Professor at Heidelberg, unites anatomy and the history of the development of animals in their mutual and intimate relation as animal morphology. It has for its first object the recognition of the intimate relations amongst different degrees of animal organisation, and further, to consider the anatomy of man as illustrated by the knowledge of the construction of lower organisms. This programme evidently excludes all descriptions and one-sided observations which cannot be used for the above purpose. The first number contains papers on the extreme ends of the animal world, viz., Man and Infusoria, and thus illustrates the end in view most perfectly. The *Jahrbuch* will be supplemented annually by a yearly report of the progress of the anatomy of Vertebrata. This serial appears quarterly in numbers of from 6 to 10 sheets of text, with plates, at the price of from 6 to 9 marks.

Zeitschrift für Anatomie und Entwickelungsgeschichte ("Journal of Anatomy and History of Development"), edited by W. His and W. Braune, Professors of Anatomy at the University of Leipzig. The principal object of this new serial is to be the knowledge of the human body; but papers will also be received which touch upon this theme from a somewhat more distant point of view. At the same time attention will also be turned to the practical side of this subject as well as the theoretical, and materials will be offered to the medical man which will be of immediate use to him in his sphere of action. The double number published of this serial shows that its programme has very wide limits and will eventually be of interest to the zoologist and anatomist, as well as to the practical physician. A number of this serial will be published every two months, containing about five sheets of text and five plates, at the price of from 6 to 8 marks.

NOTES

THE Local Secretaries of the Bristol Meeting of the British Association are doing all in their power to make it in every way a success, and to secure the comfort and enjoyment of those members who may attend; and we think we may promise all who do a pleasant time of it. Although the railway companies have obdurately refused to grant any special concessions to those who will attend the Bristol Meeting, we have reason to believe that the usual complaints as to hotel charges will not have to be made; all the principal hotels have given assurance that their tariffs will not be raised, except in the case of beds, the charge for which, quite naturally, will be slightly increased. There are many places of scientific as well as general interest in and around Bristol; and the Bristol Museum, one of the best provincial collections in the kingdom, will be temporarily enlarged for the occasion. Excursions to various places will be arranged, and the Mayor and inhabitants of Bath have signified their wish to receive a visit from the Association. At the *soirée* on August 26 the Bristol Microscopical Society, assisted by the Naturalists' Society and the Bath Microscopical Society, has undertaken to give a systematic microscopic demonstration of the natural history of the neighbourhood; a novel feature will be the number of living objects which will be exhibited. At the second *soirée*, Aug. 31, a number of objects of great scientific interest will be exhibited. A special Guide Book is being compiled, and a very useful map of the country for many miles round Bristol has been prepared.

THE section of the Eclipse Expedition which went to Camorta returned last week. No detailed news has been received from the Siam party.

AT its last private sitting, the Paris Academy of Sciences was apprised by its Administrative Commission that the expense for the several Transit of Venus expeditions had exceeded by 80,000 francs the sum granted by the Government. A supplementary credit will be asked for from the Versailles Assembly; and M. Leverrier proposed to offer to the Government the instruments used by the several expeditions, which now belong to the Academy. These 6-inch and 8-inch refractors are large enough to be utilised in the establishment of local observatories in several provincial towns of France and Algiers. The motion was unanimously accepted on condition that the said instruments should be lent to the Academy for the Transit expeditions of 1882.

THE number of Prof. Huxley's students in Edinburgh University now amounts to upwards of 350.

THE gentlemen whose names we mentioned in a previous number (vol. xi. p. 497), were, at the annual election meeting of the Royal Society last Thursday, elected Fellows.

THE Norwegian Government has granted a credit of 4,000*l.* for an expedition to be sent out next year under the scientific direction of Dr. Mohn, for the exploration of the sea between Iceland, the Faroe Islands, Spitzbergen, and Jan Mayen. The commander of this expedition will be Capt. Carr Wile, of the Royal Norwegian Navy, who is now in England gathering information as to the work done by the *Challenger*.

WE take the following from the *Academy*:—Under the title of the Belgian Society of Dredging and Marine Exploration, a society has been formed for the systematic exploration of the North Sea. The annual subscription is to be 15 francs. The materials as collected are to be submitted to various scientific men who have made the different departments their special study, and are afterwards to go to form a central collection accessible to all the members. Duplicate specimens not required for this purpose are to be sold each year at one of the meetings of the Society. The circular which has been issued suggests that, by means of such a society, Belgium may be able to contribute its share to the advancement of that branch of science for which so much has been done by our own countrymen. We need not say that we wish it every success.

WE are glad to learn that Capt. Hoffmeyer, director of the Royal Danish Meteorological Institute at Copenhagen, intends to continue the publication of his daily Synoptic Meteorological Charts for the third quarter, June to August 1874. The charts are constructed from every available source for the region embraced, viz., from about lat. 30° to 70° N., and from long. 40° W. to 40° E. of Paris. The cost of subscription in this country is 12*s.* 6*d.* for the three months, but as only a limited number is printed, application should be made at once to Mr. R. H. Scott, director of the Meteorological Office, 116, Victoria Street, London, S.W.

WE understand that Prof. Boyd Dawkins, of Owens College, leaves this week for Sydney, *viâ* the Suez Canal. After conducting a geological exploration in Australia, he intends returning by San Francisco, reaching England in October, thus making the circuit of the world in about 120 days.

AT its last sitting the Council of the Paris Observatory passed resolutions relating to the observation of intra-Mercurial planets and the determination of the velocity of light by the satellites of Jupiter and by aberration. These last researches are intended for the verification of the numbers obtained by the parallax of the sun and by Cornu's direct experiments. A beginning will be made as soon as the necessary funds have been granted by the Ministry. The intra-Mercurial planets are to be observed photographically when crossing the disc of the sun. These researches will be commenced as soon as the fitting up for photographic purposes of the great Arago refracting telescope is finished.

IT is expected that the French Academy of Sciences will hold its annual meeting for distribution of prizes on the 21st inst.

M. LABOULAYE, a Professor in the College of France and an influential member of the French Assembly, read, at the sitting of the latter on June 5, a report, drawn up by him in the name of a special commission, asking the establishment in France of Free Universities. M. Wallon, the French Minister of Public Instruction, is said to be greatly in favour of the scheme.

A STRANGE case of poisoning is reported from Stettin. A gentleman had bought a hat in a shop there, and, after having worn it for one or two days, was troubled with unbearable headache; at the same time little ulcers formed upon his forehead, his eyes were inflamed, and the whole of the upper part of his head was much swollen. It was evident that these symptoms were caused by the hat, and upon examination by a chemist it was found that the brown leather in the inside of the hat was coloured with a poisonous aniline dye. It appears that inflammation is unavoidable when this dye is in contact with any part of the skin.

DR. OSCAR FRAAS, director of the Natural History Museum and Professor of Geology at Stuttgart, has arrived at Beyrût, invited by Rustem Pasha; he intends to study the Lebanon geologically and mineralogically, and to work out a geological map of that range of mountains.

THE great meeting of German ornithologists took place at Brunswick on May 20–23. Brehm, Cabanis, Homeyer, Blasius, Reichenow, Pralle, and many other members of the two ornithological societies, were present. The first meeting led to the union of the two societies. It was resolved to request all the members to report to a Committee from time to time all observations of interest to science, agriculture, or the economy of forests, that they may make, on the life, manners, use, &c., of German birds. The Committee is to publish the materials thus obtained, after due consideration and sifting.

IN a letter dated Constantinople, May 20, the *Kölnische Zeitung* gives some details on the earthquake which took place on the west coast of Asia Minor. On the 11th of May, at 5 A.M., a severe shock was felt at Smyrna which lasted several seconds. Two other shocks followed the same morning, and although many houses were shaken, yet none fell. It is thought that the centre of the earthquake was in the Sporades Islands. According to other reports on the dreadful earthquake of the 3rd–5th of May in the interior, the sources of the Mæander river were indicated as the centre of the volcanic action. This point is situated in the canton of Ishikli, to the south of Ushak and Afium Karahissar. The destruction was fearful at Ishikli: about 1,000 houses were completely destroyed and several thousand people killed; only about twenty dwelling-houses and two mosques are now standing. In the village of Yivril not one of 300 houses is left, and about 450 dead have been extricated from the ruins. Not far from there an immense chasm has formed in the ground, from which is running a stream of hot water. The village of Yaka is likewise annihilated. In other villages, as Savasli, Karayapli, &c., the inhabitants escaped with a violent shock.

A REUTER'S telegram, dated New York, June 7, states that an earthquake has occurred at the Loyalty Islands, a tidal wave at the same time sweeping over three villages.

AT a meeting of the Upper-Rhenish Geological Society, which took place at Donaueschingen on May 23, Dr. Knop, of the Polytechnic Institution of Karlsruhe, read an interesting paper on the phenomenon of disappearance of the waters of the Danube, in some rugged piece of ground over which the river flows near Immendingen. Dr. Knop has been ordered by the Baden Government to investigate the matter scientifically. It is supposed that the little river Aach, which flows into the Lake of Constance, and thus into the Rhine, is the result of this phenomenon, as there can be no doubt that the volume of the Danube is considerably diminished after having passed over the spot in question. The present, *i.e.* the visible source of the Aach, is near the village of the same name, and the river flows from a cavern of several hundred feet in circumference, from underneath overhanging rocks, with great velocity and force; it turns several waterwheels close to its source. A chemical analysis of its water is now being made, with a view of ascertaining whether the water is of the same composition, *i.e.* contains the same impurities as that of the Danube.

SEVERAL writers in the *Belgique Horticole* have given the results of their experience in managing marine aquariums. A certain Mr. Bauwens says that he has possessed a marine aquarium now nearly ten years, *and the sea-water has never been renewed*. All that he does is to add fresh water as the salt water evaporates, the same degree of saltness being invariably maintained. Various species of small seaweeds and several molluscs thrive without further care, but some species of Actinia raised in the same medium were starved to death when the owner was absent from home for a considerable time. He made it a practice to feed them with a little mould, worms, or even raw meat.

THE quality of water in relation to its fauna and flora has been the subject of investigation by some of the French Academicians. In substance the results seem to prove that water in which animals and plants of higher organisation will thrive is fit to drink; and, on the other hand, water in which only the infusoria and lower cryptogams will grow is unhealthy. If the water become stagnant and impure, aquatic plants of the higher order will languish and disappear, and the half-suffocated fish will rise near the surface and crowd together in parts where there may still be a little of the purer element trickling in, and if driven from these places they soon die. *Physa fontinalis* will only live in very pure water; *Valvata piscinalis* in clear water; *Limnæa ovata* and *stagnalis* and *Planorbis marginatus* in ordinary water; and, finally, *Cyclas cornea* and *Bithynia impura* in water of middling quality—but no mollusc will live in corrupt water. Plants also exercise a reactive influence on the quality of water. The most delicate appears to be the common watercress, the presence of which indicates excellent quality. Veronicas and the floating water-weeds flourish only in water of good quality. The water-plantain, mints, loosestrife, sedges, rushes, water-lilies, and many others, grow perfectly well in water of moderately good quality. Some of the sedges and the arrow-heads will thrive in water of very poor quality. The most hardy or least exacting in this respect is the common reed, or *Phragmites communis*.

AMONGST the recent additions to the Southport Aquarium are a Sturgeon, seven-and-a-half feet in length, captured at low tide in the estuary of the Ribble, and a large specimen of the Wolf Fish (*Anarrhichas lupus*), from Norway.

THE foundation-stone of an aquarium was laid at Rothesay, in the Island of Bute, on Saturday.

TO-DAY, at the Mansion House, a public meeting will be held in connection with the Cambridge University Extension Scheme; the Lord Mayor will preside.

IN last week's *Journal* of the Society of Arts will be found a very interesting paper by Mr. P. F. Nursey, C.E., on Toughened Glass.

THE Conversazione of the Society of Arts will be held on the 25th inst. at South Kensington Museum.

MR. WATTS, who visited Iceland last year, and ascended the Vatna Jökel to a higher point than had previously been reached by any traveller, sailed from Granton last week for Reykjavik. He is to resume his travels in the interior of Iceland during the present summer. There is still a large portion of the island unexplored, and, as it is very mountainous and covered in some places with perpetual snow, the work of exploration is attended with great danger and difficulty. With the assistance of some of the Icelanders, however, it is hoped that this inhospitable region may be crossed over and examined, so that its topographical and mineralogical character may be determined more exactly than has yet been done.

A LETTER from the Secretary of the Italian Society of Sciences to the Paris Academy, states that the Italian *savants* have agreed to support a proposition issued by the Royal Society of Edinburgh, that the large tables of logarithms calculated by M. Prony should be published at the common expense of all nations wishing to contribute to an enterprise of common interest for mankind. These tables were calculated as far back as the beginning of the present century, at the expense of the French Government. The manuscript, which escaped the vandalism of the Communists, is safe in the Archives of the Academy, and cannot be published solely for want of funds.

DR. NACHTIGALL, the African explorer, has received the commands of the German Emperor to wait upon his Majesty at Ems. The Berlin Geographical Society gave Dr. Nachtigall an enthusiastic reception on the 2nd inst., at which the eminent traveller briefly sketched his six years' work in North Africa. The reception was followed by a banquet in the Zoological Gardens, at which Dr. Nachtigall received an autograph letter from the Emperor conferring upon him the Order of the Royal Crown. On Tuesday last the traveller was received in audience by the Imperial Crown Prince at the new Palace at Potsdam.

PREPARATIONS are being made for the erection of a handsome new museum in Dunedin, New Zealand.

THE boys and girls who assembled in the theatre of London University on Monday for the distribution of prizes and certificates gained in the Cambridge University local examinations were particularly fortunate in having as chairman Sir W. V. Harcourt. The address he gave was unusually pointed and impressive; the criticism he made on the results of these examinations, and the wholesome truths he uttered on what education really means, must have had an excellent effect on many of those who heard them, both old and young. "The object of education," the chairman reminded his hearers, "was not the immediate knowledge which it gave them, but it was the instrument by which they might learn hereafter." When parents and teachers are universally impressed with this great truth, we may expect to see something like a revolution take place in our educational systems. These local examinations have one excellent result in bringing out the directions in which particular classes of pupils are apt to fail, and ought to be of great service to teachers who aim at making a science of their profession.

OWENS COLLEGE, Manchester, has received the first instalment, 57,000 dols., of a legacy left to it by Mr. Charles Clifton, an American engineer, a native of Yorkshire. A considerable additional balance is expected to be handed over presently.

THE *Pandora*, three-masted schooner, originally a despatch vessel belonging to the Government, and which was purchased a few months ago from the Admiralty for private Arctic exploration, is now lying in the inner dock at Southampton, after having undergone a thorough overhaul and refit. The *Pandora* has been specially adapted for an Arctic cruise. She will leave England about the 18th inst., and, as Lady Franklin is understood to be largely interested in her equipment, the *Pandora* will probably follow in the footsteps of M'Clintock in search of further remains of Sir John Franklin. The vessel is propelled by a feathering screw, is of 439 tons burden, and a quick sailer. The *Pandora* will be commanded by Mr. Allen Young, who has already seen much Arctic service, and Lieut. Lillingston, R.N.

JUST before the leaving of the Arctic Expedition a deputation from the Bremen North Pole Society visited Portsmouth with a view to consulting Capt. Nares regarding co-operation between the English Expedition and a German Expedition which may possibly be sent out next year.

THE first Annual Report of the Yorkshire College of Science at Leeds is as satisfactory as could be expected. The College was opened in the end of last October with three professors—A. W. Rücker, Mathematics and Physics; Dr. T. E. Thorpe, Chemistry; and A. H. Green, Geology and Mining. Though the number of day-students has been small, the professors report in satisfactory terms of the progress that has been made. In addition to the day lectures, short courses of evening lectures have been given, which have been most successful. At the request of the Wakefield branch of the Ladies' Council of the Yorkshire Board of Education, arrangements were made for the delivery at Wakefield of a course of lectures, by Prof. Green, on the Geology of the West Riding; the lectures were in every way a success, and this field of operations is likely to be developed. The Clothworkers' Company had endowed a Chair of Textile Industries; the professor, Mr. W. Walker, commenced his lectures to a good class, but for some reason resigned his chair in January. On the whole, this Report is an encouraging one, and if the friends of the scheme only persevere and see that the College is founded on a sufficiently broad basis, we have no doubt of its ultimate complete success.

THE following statistics have been published by the French Minister for Public Instruction:—Thirty per cent. of the population cannot read or write, but the proportion is smaller amongst the males, as the conscription lists give only nineteen per cent. at nineteen years of age. There are thirteen scholars for every 100 inhabitants, and one school for every 500, or 70,000 schools for the whole of France. The expenses of primary education are 70,000,000 fr.—about 40*l*. per school, or about 1*s*. 8*d*. per head of inhabitants, or 12*s*. per pupil.

WE regret to learn from the *Geographical Magazine* that through the omission of the French Commissioners to ask the German Government to appoint a Commissioner to the forthcoming Geographical Exhibition at Paris, it is not likely to be very complete so far as maps are concerned. The absence of the great German map-publishing firms would be matter for regret.

THE additions to the Zoological Society's Gardens during the past week include a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Mr. Charles Wilson; a Kuhl's Deer (*Cervus Kuhlii*) from the Bavian Islands, two Victoria Crowned Pigeons (*Goura Victoriæ*) from the Island of Jobie, two Bornean Fireback Pheasants (*Euplocamus nobilis*) from Borneo, two Great Black Cockatoos (*Microglossa aterrima*) from New Guinea, a Derbian Screamer (*Chauna derbiana*) from S. America, purchased; a Chimpanzee (*Troglodytes niger*) from W. Africa, six Argus Pheasants (*Argus giganteus*) from Malacca, deposited; four Peacock Pheasants (*Polyplectron chinquis*), an Eland (*Oreas canna*), and a Virginian Deer (*Cervus virginianus*) born in the Gardens.

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, Nos. 3 and 4, 1875.—These parts contain the following papers:—Remarks on electro-dynamics, by F. Zoellner. These refer to Ampère's law and Helmholtz's potential law.—On the proportion of temporary magnetism to the magnetising force and its relation to the reciprocal action of the metallic particles, by E. Boernstein.—Remarks on the paper of Dr. Streintz, on the torsion oscillations of wires, by O. E. Meyer.—On the conducting resistance at the points where metallic conductors touch, by F. C. G. Müller.—On the specific heats of the elements carbon, boron, and silicon, by Dr. H. F. Weber; this is the first paper on the subject, and treats on the dependence on temperature of the specific heats of the isolated elements in question.—On the path of the rays of light in a spectroscope, by Dr. J. L. Hoorweg.—On electrodes which cannot be polarised, by A. Oberbeck.—On the conduction of electricity in electrolytes, by W. Beetz.—Supplement to K. L. Bauer's paper (vol. 153, p. 572, of these *Annals*) on the apparent position of a point of light situated in a denser medium, by the author.—General theorems on the images of spheric mirrors and lenses, by the same.—On the theory of the process of assimilation in the vegetable kingdom, by E. von Benkovich.—On a simple method of finding the poles of a rod magnet, by F. C. G. Müller.—On the determination of the velocity of light and the parallax of the sun, by A. Cornu. This paper is taken from the *Comptes Rendus*.—On the unipolar conduction of electricity through layers of gases of different conducting capacity, by C. Braun.—New researches on the currents in electric machines, by F. Rosette.—Some remarks on Helmholtz's theory of vowels, by E. van Qvanten.—On the theory of anomalous dispersion, by H. Helmholtz.—On an electric fall machine, by H. Waldner.—On the experimental determination of diamagnetism by its action of induction, by A. Toepler.—On an optical method of studying the oscillation of solids, by O. N. Rood.—On a new kind of variation sounds, by V. Dvorak.—On the spectrum of the zodiacal light, by Arthur W. Wright (from the *American Journal of Science*).—Some remarks on Thomson's electrometer, by K. A. Holmgren.—Electroscopic note by the editor.

Geographical Magazine, May.—A long and interesting article on the late Admiral Sherard Osborn is the first and chief article in this number, and is followed by one on the Arctic Expedition. Other articles are on "The Salt-farms of the Loire," by Horace St. John; an interesting account of the town of Kulja, in Russian Turkestan, by A. Vámbéry; on the Khivan Mission to India in 1871, by Robert Michell; a short article on Dr. Nachtigall's travels in Africa, with a well-constructed map; besides reviews, reports of societies, &c.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, April 1.—In continuation of his article in the last number, Dr. Hann proceeds to calculate from the formula (I.) the gradients of two storms, one of which was violent at Vienna on January 27, 1874, and the other a tropical hurricane which passed over the island of St. Thomas on August 21, 1871. In the first case $\triangle B$, expressed in millimetres per 50 miles, amounts to 3·125, of which 2·7 is due to the rotation of the earth, and ·4 to centrifugal force. In the second, the earth's rotation causes a difference of 1·25, and centrifugal force of 8·87, the whole $\triangle B$ being 10·12. A difference of pressure amounting to 9·02 at a distance from the centre of 57 miles, is caused in this case by a velocity of 30 metres per second. Thus, in storms of small diameter, the effect of centrifugal force greatly exceeds, and in our cyclones falls far short of, that of the rotation of the earth. If the air streams towards or (in lofty regions) from the centre, another factor must be introduced into equation (I.) representing resistance to movement. Now, in spiral gyration, the full centrifugal force is not exerted, and we may divide the real velocity into two components, one in the direction of the tangent, and the other at right angles to it. Calling the angle between the direction of movement and the tangent i, the first component will be represented by $v \cos i$, and on this depends the centrifugal force. Finally, we have, according to Ferrel, for a spiral storm the equation—

$$\text{(II.)} \quad \triangle B = \frac{l}{287\cdot 4} \cdot \frac{B}{T} \cdot \frac{(2n \sin \phi + u)v}{\cos i}$$

where $u = \dfrac{v \cos i}{r}$ where r = distance from axis of rotation. Dr. Hann remarks that that portion of the gradient derived from $2n \sin \phi v$ is really independent of the value of i, but according to the formula it increases with the increase of i, and this must be an error. Besides, the second factor, representing centrifugal force, on analysis appears to be independent of i, and so we get too large a quantity for the gradient. With respect to the velocity of the wind, we see that the rate cannot be proportional to $\triangle B$ alone in all parts of the cyclone in the same latitude; and further, that in different latitudes the value of v for the same gradient is nearly inversely proportional to the sine of the latitude. On the subject of tornadoes, Dr. Hann says that if the earth were not rotating, the tendency of the air to restore equilibrium would prevent any greater disturbances than those which are now observed at the equator. Water before at perfect rest, when an orifice is made in the containing vessel, flows through without producing circulation, but the least original movement causes rapid rotation. In tornados the influence of the rotation of the earth is small in comparison with that of the original condition of the atmosphere. Hence the variable direction of rotation. Large cyclones are not found near the equator. Tornadoes, having no constant force acting to maintain them, must soon be spent. The direction of progression of cyclones can be explained by the inequality of centrifugal force on their north and south sides. On the north side, that part of the gradient depending on $2n \sin \phi$ is greater than on the south side; the cyclone accordingly moves in the direction of least pressure, viz., towards higher latitudes.

Der Zoologishe Garten.—In the number for March, J. von Fischer remarks on the habits in captivity of the common and Mozambique Ichneumons (*Herpestes ichneumon* and *H. ornatus*); the former is more diurnal and arborial in its manner of life, and is much more playful and tameable than the latter.—A. Petry gives an account of a viper (*Pelias berus*) which gave birth in solitary confinement to one young one, and *fifteen weeks* later to three more.—E. Buck remarks on the life of various species of *Acineta* in the aquarium, and Herr Director Rueff on the history of zoological gardens.—A curious instance of the attachment of the cuckoo (*Cuculus canorus*) to its egg is recorded on the authority of Herr Förster Amort by Victor Ritter von Tschusi-Smidhofen, and Herr von Bothmer gives an interesting account of two tame otters (*Lutra vulgaris*).

Jahrbuch der Kais-Kön. geologischen Reichs-Anstalt. No. 3, band xxiv., 1874. *Hierzu:* Dr. G. Tschermak, *Mineralogische Mittheilungen*, band iv., heft 3.—The first paper in this number of the *Jahrbuch* is one by Ludw. v. Vukotinovic, on the tertiary strata in the neighbourhood of Agram (Croatia). These are divided into two groups, the *lower*, consisting of limestone (nullipore in part), with which is associated sandstone, sometimes fine-grained, sometimes coarse, and pale grey sandy marls; the *upper* (brackish group) being composed of grey and yellowish brown sandstone, yellow or white sand, and gravel and shingle. In general, a striking resemblance can be traced between these Agram tertiary deposits and the strata of the so-called Vienna basin. This holds good with at least the Upper Tertiary or Miocene; but as regards the brackish water group, some difference obtains. But this the author believes is only what might have been expected when consideration is had to the varying local conditions under which the deposits must have been accumulated. An account of the brown coal of Croatia and Slavonia is furnished by C. M. Paul. He tells us that brown coal occurs at five different geological horizons in the Tertiary strata of those districts. According to the index, we should have a paper by Dr. O. Lenz, on the ancient glacier of the Rhine, but it does not appear in this number.—Among the *Mineralogische Mittheilungen* we note specially two papers: Petrographical observations on the west coast of Spitzbergen, by Dr. R. v. Drasche; and on some trachytes of the Tokay-Eperieser Mountains, by Dr. C. Dölter. The rocks this author describes are augite andesite (augite andesite lava), amphibole-andesite, quartziferous augite andesite, rhyolite (quartziferous sanidine trachyte), and sanidine trachyte lava; analyses of a number of these rocks are given. There is also an interesting preliminary notice of a new circular-polarising substance, by Dr. C. Hintze.

Allgemeine Schweizerische Gesellschaft für die gesammten Naturwissenschaften.—The publication of this society, vol. xxvi (1874), contains only one, but a very elaborate treatise, with two plates, on the ants of Switzerland. It gives their classification, their habits, anotomical and physiological notes regarding them, and remarks on their geographical distribution, together with many new observations regarding their mode of life, &c. The author is Dr. Auguste Torel. The treatise occupies no less than 480 quarto pages, and is written in French.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, June 3.—Prof. Abel, F.R.S., &c., in the chair.—The following papers were read:—On the effects of pressure and cold upon the gaseous products of the distillation of carbonaceous shales, by Mr. J. T. Coleman. He finds that 1,000 cubic feet of the gas produced in such large quantities at shale oil works when submitted to pressure will give about one gallon of volatile hydrocarbons fit for improving the illuminating power of ordinary coal-gas.—On the agricultural chemistry of the tea plantations of India, by Dr. C. Brown, giving analyses of the ashes of tea and the effect of fertilisers on the growth of the plant.—On the structure and composition of certain pseudomorphic crystals having the form of orthoclase, by Mr. J. A. Phillips.—Note on the sulphates of narceine and other narceine derivatives, and On the action of organic acids and their anhydrides on the natural alkaloids, Part V., both by Mr. G. H. Beckett and Dr. C. R. A. Wright.—On the action of chlorine on pyrogallol, by Dr. J. Stenhouse and Mr. C. E. Groves; with an appendix by Mr. Lewis, on the crystalline forms of *mairogallol*, one of the products.—On nitro-alizarin, by Mr. W. H. Perkin, F.R.S. This compound, obtained by the action of nitric acid on acetyl-alizarin, dyes fabrics mordanted with alumina of an orange colour, whilst the amido-alizarin obtained from it by reduction gives a fine purple.—On some metallic derivatives of coumarin, by Mr. R. Williamson.—On the action of dilute mineral acids on bleaching powder, by F. Kopfer.

Geological Society, May 26.—Mr. John Evans, V.P.R.S., president, in the chair.—The following communications were read:—On some peculiarities in the microscopic structure of felspars, by Mr. Frank Rutley. The observations recorded in this paper related mainly to some exceptional features in the striation of felspars from various localities, involving a consideration of the extent to which dependence may be placed on the discrimination of monoclinic and triclinic felspars by the methods usually recognised in ordinary microscopic research. Some other peculiar structural features were likewise noticed, and the effects which might be produced on polarised light by the overlap of twin lamellæ in thin sections of felspars, when cut obliquely to the planes of twinning, were also considered. The paper terminated with a list of conclusions deduced from the observations recorded. These conclusions mostly related to matters of detail; but the general inference drawn by the author was that the present method of discriminating between monoclinic and triclinic felspars by ordinary microscopic examination answers sufficiently well for general purposes, although it is often inadequate for the determination of doubtful examples, and that such examples are of more frequent occurrence than one would at first be led to suspect.—On the Lias about Radstock, by Mr. Ralph Tate, A.L.S. In this paper the author described several sections in the Lias of the neighbourhood of Radstock, in Somersetshire, with special reference to their palæontological contents and to the question of the division of the Lias into zones in accordance with the species of Ammonites occurring in different parts of the series. He maintained that although the Lower Lias in this district only attains a thickness of twenty-four feet, this is due to poverty of sediment; and that whilst by this means the zones are compressed, and the species of Ammonites brought almost into juxtaposition, the succession of Ammonite-life is as regular in the Radstock Lias as in the most typical districts. Much of the opposition to the doctrine of zoological zones he ascribed to erroneous discrimination of species. The paper included tables of sections and lists of fossils, with the arguments founded upon them, in support of the above opinion. A few new species were described under the names of *Trochus solitarius*, *Cryptæna affinis*, *Cardita consimilis*, and *Cardinia rugulosa*.—On the axis of a Dinosaur from the Wealden of Brook, in the Isle of Wight; probably referable to *Iguanodon*, by Prof. H. G. Seeley, F.L.S. This perfect specimen, preserved in the Woodwardian Museum of the University of Cambridge, is 3½ inches long and 3¼ inches high. The odontoid process is anchylosed to the axis, and projects forward as in the axis of birds, so as to articulate with the occipital condyle of the skull. The pre- and postzygapophyses are situated much as in birds; as are the two ovate pedicles, on the anterior part of the side of the vertebra to which the cervical rib was articulated. But posteriorly the articular surface for the third cervical vertebra is transversely ovate and slightly concave. The neural spine is compressed from side to side, more so in front than behind. Among mammals, the nearest resemblance to this kind of axis is seen similarly in the whale; and among reptiles the crocodile has a two-headed rib; but the other characters are more like those of *Hatteria*, which the author regarded as a near ally of the Crocodilia and Chelonia, and as wrongly united with the Lacertilia.—On an Ornithosaurian from the Purbeck Limestone of Langton, near Swanage (*Doratorhynchus validus*), by Prof. H. G. Seeley, F.L.S. The author obtained these specimens (a lower jaw and a vertebra) in 1868, and described them in the "Index to the Secondary Reptilia, &c., in the Woodwardian Museum in 1869 as *Pterodactylus macrurus*. He now believed that the Ornithosaurian vertebræ from the Cambridge Greensand, which have been regarded as caudal, are really cervical, and therefore that the analogy on which this vertebra was determined to be caudal cannot be sustained; he proposed to adopt for his species Prof. Owen's specific name *validus*, given in 1870 to a phalange of the wing finger from the same deposit. The vertebra is five inches long, relatively less expanded at the ends than similar vertebræ from the Cambridge Greensand, has strong zygapophysial processes and a minute pneumatic foramen. The lower jaw, as preserved, is 12¼ inches long. The symphysis extends for five inches, and is about one-eighth of an inch deep, and divided into two parts by a deep median groove. The teeth extended for eight inches along the jaw, and about seven or eight occurred in the space of an inch. They were directed outward in front, and became vertical behind. Where the rami are fractured behind they measure 2¼ inches from side to side.

Zoological Society, June 1.—Dr. Günther, F.R.S., V.P., in the chair.—Mr. Sclater made some remarks on the most noticeable of the animals seen by him during a recent visit to the Zoological Gardens of Rotterdam, the Hague, Amsterdam, Antwerp, and Ghent.—Mr. Sclater exhibited the typical specimen of his *Centropsar mirus* (P.Z.S. 1874, p. 175, Pl. xxvi.), and stated that on a more careful examination of it he had come to the conclusion that it was a made-up skin.—Mr. Edwin Ward exhibited the two lower canine teeth of a Hippopotamus from St. Lucia Bay, S. Africa, obtained by the Hon. C. Ellis, and supposed to be the largest ever obtained. They measured from end to end round the outer curve thirty inches.—Mr. G. E. Dobson read a paper on the genus of Insectivorous Bats named *Chalinolobus*, by Dr. Peters, and gave the descriptions of several new or little known species of this group, which he proposed to divide into two sections, *Chalinolobus* and *Glauconycteris*.—A communication was read from Mr. Henry Adams, wherein he gave the descriptions of two new land shells. These were proposed to be named respectively *Eurycratera farafanga*, found on a sandy plain in the S.W. of Madagascar, near the Farafanga River, and *Pupinopsis angasi*, from the Louisiade Archipelago, in the S.E. of New Guinea.—Mr. G. French Angas communicated the descriptions of three new species of shells from Australia, proposed to be called *Helix forrestiana*, *H. broughami*, and *Euryta brazieri*.—Mr. A. G. Butler read a paper describing several new species of Indian Heterocerous Lepidoptera.—A communication was read from Rev. O. Pickard-Cambridge on some new species of spiders of the genus *Erigone* from North America.—Mr. Herbert Druce communicated a list of the collection of Diurnal Lepidoptera made by Mr. J. J. Monteiro in Angola, with descriptions of some new species.—Mr. P. L. Sclater read a paper on several rare or little known mammals now or lately living in the Society's collection, amongst which was specially noticed an apparently new species of Muntjac, proposed to be called *Cervulus micrurus*.—A communication was read from Mr. E. L. Layard, containing notes on the birds observed by him in the Fiji Islands.—Lieut.-Col. R. H. Beddome read a paper in which he gave the descriptions of some new operculated land shells from Southern India and Ceylon. The discoveries of true *Diplomatina* in Southern India and of *Nicida* in Ceylon were alluded to as being of special interest.—Sir Victor Brooke, Bart., read some supplementary notes on African Buffaloes, in the course of which he stated that he had come to the conclusion that the West African Buffalo (*Bos pumilus*) was distinct from the East African form (*Bos æquinoctialis*).—Mr. C. G. Danford exhibited specimens of the Wild Goat (*Capro aegagrus*, Gm.), from Asia Minor, and read some notes on the distribution, habits, &c., of that species.

Royal Microscopical Society, June 2.—Mr. Charles Brooke, F.R.S., vice-president, in the chair.—Mr. J. W. Stephenson exhibited and explained a simple method which he had devised for enabling any person to measure the angle of aperture of an objective, and a number of copies of the engraved scale employed for the purpose were placed upon the table for distribution amongst the Fellows.—Mr. Charles Stewart gave an interesting account of the results of an examination into the minute structure of *Bucephalus polymorphus*, and illustrated his observations by drawings.—Mr. Slack then at some length explained the use and management of Mr. Wenham's reflex illuminator, and pointed out the means of obviating the difficulties which were found to arise when it was used in connection with objectives of large angles.

Victoria (Philosophical) Institute, June 7.—The President in the chair. This was the ninth annual meeting, and the report showed that since last year the number of subscribing members had increased by 116, and now reached 601, two-thirds of whom were country and foreign members. Papers had been read during the session by Professors H. A. Nicholson, T. R. Birks, J. Challis, and others; and the outside demand for the publications had doubled each succeeding year since 1871. The report having been adopted, the annual address was then delivered by the Rev. Robert Main, Radcliffe Observer. The address was of three sections:—1. A sketch of most important discoveries in physics, chiefly astronomical, which have been made during the last few years. 2. A slight review of some of the assumptions in two recent publications, namely, Mill's "Essay on Theism," and Strauss's "Old and New Faith." 3. A consideration of the Atomic Philosophy in connection with Dr. Tyndall's Belfast address.

BERLIN

German Chemical Society, May 24.—W. Petrieff described the products of the decomposition by heat of dibromomalonic acid, namely an oil, C_2HBr_3, and dibromacetic acid.—W. Wisth and A. Landolt have transformed bromaniline into parabromobenzoic acid, by converting it into the corresponding mustard oil $C_6H_4Br - N = C = S$, and transforming this into the nitrale $C_6H_4Br - C \equiv N$.—A. Weber has studied mononitrodimethylaniline and monobromodimethylaniline.—M. Nencky has transformed indol into nitrosoindol-nitrate

$$C_{16}H_{13}(NO)N_2 . NO_3H,$$

which sulphide ammonium converts into hydrazindol

$$(C_{16}H_{13}N - NH)_2$$

—H. Limpricht retracts his opinion of the existence of four isomeric monobromobenzenesulphonic acids, the fourth being identical with that obtained from sulphanilic acid.—F. Fittica, however, still insists upon the existence of four mononitrobenzoic acids, but makes it more improbable than ever by stating that the fourth isomeride is transformed by tin and hydrochloric acid into the body $C_{12}H_{12}N_2O$!—H. Hassenpflug has been able to convert nitrobenzene into paranitrobenzoic acid, by treating it with peroxide of manganese and sulphuric acid.—L. Klippert has studied the action of fluoride of silicium on ethylate of sodium. It results in the formation of sodium fluoride, silicium fluoride, and silicic ether.

VIENNA

Imperial Academy of Sciences, Jan. 7.—Prof. K. Puschl presented a memoir on the changes in the volume of caoutchouc by heat. The author gives as the results of his experiments, (1) that the density of caoutchouc reaches a minimum at a certain temperature; (2) that the temperature of this minimum changes according to the mechanical tension, and is the lower the greater the tension; (3) that with caoutchouc upon which no tension is applied, the temperature of the minimum of density is higher than the ordinary temperature; (4) that the reverse of this is the case with caoutchouc under strong tension.—Director von Littrow then made some communications regarding Borrelly's comet.—Prof. E. Suess presented a paper on the volcano Venda, near Padua.—Prof. Dr. Winckler then read a treatise on the integration of two linear differential equations.—Dr. Doelter gave a preliminary account of the geological nature of the Pontinic islands.—Dr. von Littrow communicated a paper on the relative capacity of different soils for conducting heat and the corresponding influence of water.—Dr. Lippmann presented a memoir on the action of iodine upon mercuric oxide. The author shows that whenever a hot solution of iodine acts upon mercuric oxide, an iodate always is formed besides the mercuric iodide, and that it is indifferent whether the solution be made in alcohol, benzine, chloride of carbon, butylic alcohol, acetone, or water.—Prof. Schlesinger then presented a memoir on a metallic barometer without mercury.

PARIS

Academy of Sciences, May 31.—M. Frémy in the chair.—The following papers were read:—Researches on sulphides, by M. A. Cahours.—A note by M. L. Saltel, on left curves.—On the alterations in the level of the Seine in the environs of Paris, from November 1874 to May 1875, by M. A. Gérardin.—On a new method of preparing highly concentrated formic acid, by means of anhydrous oxalic acid and a polyatomic alcohol, by M. Lorin.—A note by M. J. Riban, on the isomerism of the chlorohydrates $C_{10}H_{16}$. HCl.—Researches by M. E. Faivre, on the functions of the front ganglion of *Dytiscus marginalis*.—On the organisation and the natural classification of the Acarina of the Gamasea family, by M. Megnin.—Experimental researches on the toxical properties of putrefied blood, by M. V. Feltz.—On chronical aortite, by M. P. Jousset.—On a new method of treating rheumatism of the brain by chloral hydrate, by M. E. Bouchut.—On the improbability of an interior sea or lake having existed formerly on the Sahara desert, by M. Pomel.—On the influence of drought upon Cryptogamæ, by M. E. Robert.—On the origin of Phylloxera at Cognac, by M. Mouillefert.—A note by MM. Ph. Zoeller and A. Grete, on the use of xanthate of potash against Phylloxera.—A note by M. Julien, on the presence of Phylloxera in the Auvergne.—A letter from M. Villedieu, on the influence of moisture upon Phylloxera.—A letter from M. Reymonet, on the possibility of grafting vines on little trees the roots of which cannot serve as food for Phylloxera.—A letter from M. F. Moll, on the use of a mixture of soft soap and dead oil (as used for railway sleepers) against the larvæ of cockchafers and snails.—A number of communications of minor interest were then read; most of them were competition papers for the various prizes the Academy distributes annually.—Researches on the rate of magnetisation and demagnetisation of wrought-iron, steel and cast-iron, by M. M. Deprez.—A note by MM. V. de Luynes and A. Girard, on the rotatory power of crystallised sugar and on the polarimetric analysis of various sugars.—Researches on the emissive power of leaves, by M. Maquenne.—Remarks by M. A. Bechamp, concerning a note by M. Gayon, read at the meeting of April 19 last, on the spontaneous alterations in eggs.—A note by M. A. Gautier, on the production of blood fibrine.—A note by M. Grimaud de Caux, on a case of psoïtis.

BOOKS AND PAMPHLETS RECEIVED

AMERICAN.—Report of the Vertebrate Fossils discovered in New Mexico: Prof. E. D. Cope (Washington).—Eighth Annual Report of the Trustees of the Peabody Museum.—Astronomical and Meteorological Observations made during the Year 1872 at the United States Naval Observatory: Rear-Admiral B. F. Sands, U.S.N. (Washington).—Progress Report upon Geographical and Geological Explorations and Surveys West of the 100th Meridian in 1872, under the direction of Brigadier-General A. A. Humphreys, by First Lieut. George M. Wheeler; with Topographical Maps (Washington).—Religion and Science in their relation to Philosophy: Charles W. Shields, D.D. (New York: Scribner, Armstrong, and Co.).—Seventh Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri: Charles V. Riley.—Bulletin of the U.S. Geological and Geographical Survey of the Territories. No. 3, Second Series (Washington).—U.S. Geological and Geographical Survey of the Territory of Colorado: F. V. Hayden (Washington).—Third Annual Report of the Board of Managers of the Zoological Society of Philadelphia, U.S.—On the Devonian Trilobites and Molluscs of Ereré, Province of Pará, Brazil: Prof. Ch. Fred. Hartt and R. Rathbun.

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THURSDAY, JUNE 17, 1875

CROLL'S "CLIMATE AND TIME"

Climate and Time in their Geological Relations; a theory of Secular Changes of the Earth's Climate. By James Croll, of H.M. Geological Survey of Scotland. (London: Daldy, Isbister, and Co., 1875.)

MR. CROLL is well known as an original thinker of considerable power, who has turned his attention to the physics of geology, and has produced a series of remarkable papers on questions of the highest interest in that subject. His views are opposed in many respects to those accepted by other influential thinkers, and have given rise to a considerable amount of controversy. Hitherto they have been scattered in papers to various periodicals, and it has been difficult to obtain a consecutive view of them. The work which is now issued, while not an actual reprint of previous papers, is a complete exposition of their contents, or at least of that part of their contents that Mr. Croll is prepared to stand by, some of the arguments that occur in his papers being omitted in his book. We are now therefore able to judge fairly what truth there is in Mr. Croll's ideas, and to compare them with those of his opponents. Even were all his ideas untenable, we should still have to thank him for his vigorous discussion of these interesting questions, but there can be no doubt that in many instances he proves his point.

Mr. Croll does not possess the happy faculty which some authors have of carrying his readers with him: on the contrary, his style is so controversial, that to agree with him is to have the feeling of being vanquished, and the reader is throughout set on his metal to find out some flaw in the argument. This, as in most cases of controversy, it would not be difficult to do; but we must confine ourselves to the discussion of his main results.

One peculiarity of Mr. Croll's arguments must here be noticed. After having assumed certain figures and arrived by their means at definite results, he proceeds to show that these figures are unreliable, and then to state that their unreliableness will not affect his results; or else, in order to bring his results more into accordance with received opinions and probable facts, he generously halves them or diminishes them still more, apparently unaware that had his arguments been correct and his first results the true ones, he would have proved too much and refuted himself. Examples of this peculiarity will be seen in the sequel.

The first question discussed is the heating influence of the Gulf Stream. To estimate this Mr. Croll uses the method of heat units, and prides himself on doing so. The method is an undeniable one, and is perhaps the only one by which the influence of the high specific heat of water can be made manifest. Mr. Croll compares the number of foot-pounds conveyed by the Gulf Stream into temperate regions with the number due to the heat of the sun shining directly on those regions. The relative value of these depends on the absolute value of each. The volume, velocity, and temperature of the Gulf Stream have been very variously estimated; and as to the sun's heat, when we remember how much the diathermancy of the air depends on its condition, we may not be able to accept with such confidence as Mr. Croll, the estimates of Pouillet; yet with every possible allowance, when the influence of a vast body of heated water is calculated, it will undoubtedly be much greater than would have been previously supposed, and actually amounts to a very considerable fraction, say $\frac{1}{16}$ of the whole of the sun's direct heat on the North Atlantic. Dr. Carpenter * brings objections against this method which render, in his opinion, the "figures" "utterly valueless." The first of these is that Mr. Croll does not give a correct account of the difference in temperature between the northern and southern hemispheres in assigning it to the transport of heated water by ocean currents; but it is obvious that the question as to where the Gulf Stream obtains its heat is entirely distinct from that as to its actual amount. The second objection, that since the temperature of the ocean is seldom more than 82°—86°, while the "direct heat of radiation" may amount to 215°; and therefore that "the heat lost by evaporation from the sea must be far greater than that lost by radiation from the land," is just one that shows the *value* of Mr. Croll's method. For, when treated in this way, the above figures show that the sea contains *more heat units* in its heated surface stratum than the layer of land that is influenced by the variations of surface-temperature, and that therefore the water at the equator is, as Mr. Croll states, the best adapted for retaining the heat of the sun, which is in reality no more than an elementary result of its high specific heat. Mr. Croll considers that the influence of the Gulf Stream is indirect, being manifested by the warming of the S.W. winds; and to the extent that he proves that the Gulf Stream raises the general temperature of the Atlantic he cannot be wrong. Were he to confine himself to the statement that the Gulf Stream and other ocean currents have a very sensible influence on the climate of the temperate regions, his position would appear to be impregnable against any who should represent its thermal effect "as very insignificant;" but when he adds that "ocean currents are the great agents employed" (to the exclusion of others) "in the distribution of heat over the globe," and estimates that the Gulf Stream alone raises the mean temperature of London 40°, he stands upon less certain ground. For these results depend on the following arguments:—(1) There is no ocean circulation but that by sensible currents; (2) The internal heat of the earth has no influence on climate; (3) The temperature of space is − 239° F.; and (4), the Gulf Stream supplies $\frac{1}{4}$ as much heat to the Atlantic as the direct rays of the sun. Of these arguments we will below discuss the first at length. The second is founded on a statement of Sir Wm. Thomson's, that an increase of temperature as great as 2° F. per foot in descending into the earth would not have an influence of more than 1° on the climate of the surface. This, however, means 1° over the present mean temperature, and in no way disproves that the internal heat of the earth does nothing in raising the temperature of its surface over that of space, an effect which it most certainly would have in a large degree. The third argument, as to the temperature of space, is therefore nothing to the point, and is moreover, as Mr. Croll himself admits, totally unreliable. We do not know the temperature *from* which the sun raises the earth, except that it is greater than that of space. The fourth argument, of course, is nothing without the first three, and the fraction $\frac{1}{6}$ we have seen may be much too large. We are not, then, in a position to estimate accurately the thermal effect of the Gulf Stream and other ocean currents; but we may consider it proved, as is indeed generally acknowledged, that they have a very sensible influence, and, as we shall see, bear a great part in the general circulation of the ocean water.

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* Proceedings of the Royal Society, June 13, 1872.

We must now examine how far Mr. Croll establishes his position that a general oceanic circulation is impossible under the influence of temperature and gravitation alone. Dr. Carpenter has already given (Proc. of Roy. Geog. Soc., vol. xviii.) his reasons for his belief in the adequacy of these influences, and his replies to Mr. Croll's objections, some of which are discussed in this volume in no less than four chapters. Although it may be familiar to most of our readers, it will be well to give here an outline of Dr. Carpenter's "doctrine."

The chilling of the salt water in both polar regions renders it heavier and causes it to sink, its place being supplied from the warmer water of lower latitudes, which is itself supplied by the motion of the water from the two poles towards the equator along the lower portion of the ocean; and these two masses meeting each other near the equator, well up there, and bring the colder water nearer the surface, while the heating of the surface water in these regions keeps up the difference between the specific gravities of the water supplied to and leaving the polar regions, on which the whole depends. These appear to be Dr. Carpenter's latest views (Proc. Roy. Geog. Soc., vol. xviii., June 1874), though Mr. Croll's objections seem, in some part at least, to be aimed at details that do not affect the fundamental conception. This is distinguished as a *vertical* circulation, because the first origination of the motion is supposed to be in the *descent* of the polar waters. Mr. Croll assents to the facts, but ascribes the circulation to the initiation of the winds, and denies that there is any circulation beyond that produced by currents. We know that currents exist on the surface, and it is generally agreed that they owe their origin, in great part at least, to the system of prevailing winds, and even on Dr. Carpenter's theory they must, so far as they tend polewards, decrease by so much the general circulation of the upper ocean; but the known or assumed under-currents are much more local, and the depression of temperature at great depths is too general to allow us to conceive that the return should be made by circumscribed currents.

In discussing the question whether the polar cold is sufficient to cause circulation, Mr. Croll first objects that the sea of the tropics is salter, and therefore denser, than that of the poles, and that this would counteract the effect of the cold. There is in reality but little force in this objection as against Dr. Carpenter's theory. The excess of temperature and of salinity counteract each other in the surface layers of the tropics, and prevent them sinking or rising; but as they have a nearly horizontal motion, according to the theory, the objection is nothing, the lower layers which alone have an upward vertical motion deriving it from a *vis-à-tergo*; and with regard to the polar area the lower layers cannot be more salt than the upper, from whence they come, according to the theory, and any *freezing* on the surface must leave the remaining water on the contrary salter.

The next objection of Mr. Croll is far more formidable, though it shows that some of the *proofs* adduced are untenable, rather than the theory itself. The drifting of icebergs from Newfoundland across the Gulf Stream, and of the Atlantic cable buoy which travelled six hundred nautical miles in seventy-six days, adduced by Dr. Carpenter as proving the southward motion of the deeper layers, proves too much according to Mr. Croll, as it proves the existence of a sensible *current*, which Dr. Carpenter admits cannot be formed by differences of gravity. This may be true, and prove that other causes operate in the motion of large masses of water; but while destroying one argument in favour of, it proves nothing in opposition to, the doctrine of general oceanic circulation. This class of objections, however, are far more forcible than theoretical ones; and the list of phenomena that may be accounted for on either theory, and of those that cannot well be accounted for on the gravitation theory, *e.g.* the southward currents of Davis Straits and the east coast of Greenland, shows that neither theory *alone* will satisfy all the conditions to be fulfilled. Mr. Croll, however, gives no satisfactory account of the greater cold of the lower strata of the South Atlantic, nor of the surging up of cold currents on eastern shores, nor of the cold water coming nearest the surface under the equator; nor does his theory give that beautiful account of the maintenance of life in the deep sea which is so dependent on the change of the water.

But Mr. Croll asserts that the gravitation theory is physically faulty, and maintains the assertion in this volume against Dr. Carpenter's last reply. In several of his arguments it is impossible not to agree with him. In examining them we will follow the order he takes. He first shows that heat at the surface, as in the equatorial regions, cannot produce circulation. But this, though essential to Lieut. Maury's theory, has not been asserted by Dr. Carpenter, who, on the contrary, states that any effect due to the heating at the equator may be practically disregarded; and why? because the heat is here applied at the top instead of at the bottom, as it should be to produce convection; but an application of cold to the top would be equivalent to heat at the bottom, and this cold is obtained in the polar area; consequently Dr. Carpenter regards polar cold as the *primum mobile*. Mr. Croll objects to this that it is the *difference* of temperature only we have to do with, and this may be said to depend on either, and accuses Dr. Carpenter with confusion of ideas; but this is scarcely fair after arguing against the heat being available to produce motion because applied at the top, showing that he perceived that not the difference *only*, but *where* the lower temperature is found is of consequence. Dr. Carpenter would say the temperature at the poles is *below* the average, no matter how that average is obtained; which is a very different thing from saying the equatorial temperature is *above* the average—since in the first case the average might be obtained, as far as the theory is concerned, by a nearly *uniform* temperature elsewhere.

The next important question raised with respect to this theory is the amount of force which is exerted to put the water in motion. This Mr. Croll shows to depend entirely and only on the amount of slope of the water-surface from the equator to the pole, and not at all upon the amount of fall from the surface in the polar regions, to the lowest depth at which the water of maximum density is found beneath the equator. Dr. Carpenter says that this "would seem irreconcilable with the simplest principles of physics," a statement easier to make than to prove. For, as Mr. Croll shows plainly, the work done *by* gravity in the descent, is done *against* gravity in the ascent at the equator, and the two counteract each other, except only the extra amount of gravity which is called into action by the shrinkage of the polar column from what would have been its size under the *average* amount of solar heat, and which alone can have any *continuous* effect. The solar heat is a constantly supplied moving force which is used indirectly in the ocean circulation, and any further amount of gravity made use of in the circuit would involve the idea of perpetual motion. Connected with this is Dr. Carpenter's assertion that there is *no* difference of level between the equatorial and polar seas. Since, however, this is the *only* proximate cause for the ocean circulation, its denial would seem to cut the ground from beneath his feet. It will be found, however, that though he denies it in one place he asserts it in another, and his theory essentially depends on it. It is true that water *tends* to find its level when disturbed, as it is by the action of polar cold, which tends to alter its level; but it is just this *tendency* that causes the circulation. If one of the forces were to be powerful enough to have its own way entirely, no motion could occur; *i.e.* if the water were too viscous, a greater permanent change of level would arise; if it were *perfectly* fluid, the equilibrium would be brought about *instantaneously* and no visible motion would be perceived. We must be content, then, with the fall of level from equator to pole to produce the circulation: is it sufficient? This depends entirely on the viscosity of water. Mr. Croll bases his argument on the experiments of Dubuat, who showed that water would not descend a slope of 1 in 1,000,000, which is much greater than the slope under discussion, and hence the fall of level is too small to cause any circulation. He replies to Dr. Carpenter's objection, that these experiments had reference to water running over solids and not over itself, by saying that one layer of molecules alone would be in contact with the solid and the rest with the water surface only. The reply is plainly beside the mark, as Mr. Croll should have seen by reading Dr. Carpenter's statement following his objection, that the difference between a fluid restoring its own equilibrium, and having a sensible motion over solid surfaces, was well known in practice to Mr. Hawksley and other hydraulic engineers. But in reality no chamber experiments can determine such a point satisfactorily; and besides this, it seems to us that an important point has been overlooked by Mr. Croll. No doubt it would be hard for a single pound of water to perform its whole circuit against all opposing frictions under the impulse of the force due to so small an amount of slope; but if large masses of water move together, the moving force would be proportional to the mass, but the friction to be overcome would be simply that of the perimeter of the tube of flow, and it is an essential part of the theory of ocean circulation that the moving water is of immense mass. This friction would not increase, like statical friction, with the mass, since the pressure would be the same at the same depths, and it is also more of the nature of shearing force than friction, and therefore nearly a constant quantity.

It does not appear, then, that anything that has been said by Mr. Croll disproves this theory of a general oceanic circulation, though he may have successfully attacked it in certain respects. Nevertheless we agree with him that "if a vertical motion follows as a necessary consequence from a transference of water from the equator to the poles by gravity, it follows equally as a necessary consequence from the same transference by the winds; so that one is not at liberty to advocate a vertical circulation in the one case and to deny it in the other."

This was the opinion also of Herschel in his letter to Dr. Carpenter, that "henceforward the question of ocean currents will have to be considered under a twofold point of view." It would take too long to discuss the other points in which Mr. Croll enters into controversy with respect to various currents, such as the Gibraltar or the Baltic, and we must reserve for another notice the interesting points connected with past time with which the latter part of the book is occupied. J. F. B.

(*To be continued.*)

HILDEBRANDSSON ON UPPER ATMOSPHERIC CURRENTS

Essai sur les Courants supérieurs de l'Atmosphère, dans leur Relation aux Lignes Isobarométriques. Par H. Hildebrand Hildebrandsson. (Upsal, 1875.)

CLEMENT LEY, in "The Laws of the Winds prevailing in Western Europe," expresses his opinion, based on observations made near Hereford on the movements of the cirrus cloud, that in general the upper currents of the atmosphere flow away from the regions of low atmospheric pressure, and converge upon regions of high pressure. This being a point of the utmost importance with reference to the general circulation of the atmosphere, M. Hildebrandsson, in December 1873, organised a systematic observation of the cirrus cloud in Sweden. Twenty of the Swedish meteorological observers engaged in the work of observation, the network of stations extending over nearly 11° of latitude, from Tomarp in the south to Qvickjock in the north. The above essay discusses these observations with great ability.

The question of the relation of the motions of the cirrus cloud to areas of high and low pressure is cleverly handled in the essay, and the method of discussion, illustrated by thirty-three charts, may be referred to as a satisfactory and exhaustive treatment of the data of cirrus observation, which are restricted only to one country. Charts I. to VIII. represent well-selected instances of storms advancing on Sweden from westward; Charts IX. to XVI. represent Sweden in the rear of storms; and Charts XVII. to XXIV. represent areas of high pressure in various directions, S., E., &c., from Sweden. Comparing the direction of the upper currents with these areas of high and low pressure, it is shown that quite near the centre of the depression area of storms the upper currents blow in directions nearly parallel to the isobars and to the winds on the surface of the earth, but that in proportion as we proceed from the centre they are turned outwards, being deflected to the right of the surface winds; in other words, they tend more and more to blow out from the area of low pressure. On the other hand, they converge upon the centre of the regions of high pressure, cutting the isobars nearly at right angles. This last point is interesting in connection with the circumstance pointed out some time ago by Hoffmeyer, that surface winds in blowing out of the areas of high pressure cut the isobars approximately at right angles. Charts XXV. to XXXII. are selected to represent instances in which Sweden lies between two storms, the one following the other with only a short interval between them. In these cases the behaviour of the upper currents from both storms and the manner in which they blend together at their contiguous margins are very instructive.

The winds on the surface of the earth, as compared with the upper currents, show, as is well known, inverse relations to areas of low and high pressure—blowing inwards upon areas of low pressure, and outwards from areas of high pressure. Consequently, as the author remarks, an area of low barometer is necessarily the region of an ascending current, which, when it has risen to a great height in the atmosphere, flows away from the central space of low pressure towards regions of high pressure, whence it sinks gradually down to the surface as a descending current, and in this manner a vertical circulation is constantly maintained between the surface of the earth and the higher limits of the atmosphere. We very strongly recommend that, as has been so successfully carried out in Sweden, a thorough and systematic observation of the cirrus cloud be generally inaugurated in other countries, so that it may be possible to chart the upper currents over a wide extent. Among the many points suggested by M. Hildebrandsson's charts is the question whether the extent and volume of the upper currents flowing outwards from storm areas be consistent with some of the views recently advanced on the theory of storms and circulation of the atmosphere. We hope meteorologists will soon take steps to occupy the important field of observation now opened up.

OUR BOOK SHELF

The Zoological Record for 1873. Edited by E. C. Rye, F.Z.S. (London: J. Van Voorst, 1875.)

IN the preface to the "Record" for 1872 Prof. Newton, the editor, announced that having intimated to the Zoological Record Association his intention to resign his post, the Council had appointed Mr. Rye, Librarian to the Royal Geographical Society, as his successor. From a glance into the present volume it is evident that it is Mr. Rye's intention to maintain the high standard of his predecessors, notwithstanding the difficulties he has had to encounter, especially in the loss of the services of Dr. Günther, whose increased duties, now that he has been promoted to the post of Keeper of the Natural History Department of the British Museum, prevent him from undertaking the *Mammalia*, *Reptilia*, and *Pisces*, as he has done for years. Mr. Rye has succeeded in obtaining the services of Mr. E. R. Alston, F.Z.S, on the Mammals, and of Mr. A. W. E. O'Shaughnessy on the Reptiles and Fishes; both which naturalists have most creditably performed their laborious tasks. Mr. R. B. Sharpe has undertaken the Birds as before, whilst Dr. Ed. von Martens, the Rev. O. Pickard-Cambridge, Mr. Rye, Mr. Kirby, Mr. McLachlan, and Dr. Lütken, have devoted themselves to their special subjects. The editor acknowledges the grant of 100*l.* from the British Association, 50*l.* from the Zoological Society, and 100*l.* from the Government Grant Committee of the Royal Society (this being the first occasion that the Record Association has been so assisted), towards the expenses of publication. The increasing necessity for the production of the volume is yearly becoming more evident, at the same time that its contents are necessarily of such a nature that there can never be a demand for it which will enable it nearly to cover its expenses. The most important scientific results of the year include the investigations of Leidy, Marsh, and Cope on the fossil American Eocene Mammalia, and Prof. Marsh's discovery of a new sub-class of fossil toothed birds, respecting which all naturalists cannot but regret that so little opportunity is given them of seeing specimens or even drawings of the great number of species now known to them by short descriptions only.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Systems of Consanguinity

I AM sorry to find that on some points I have misunderstood the views of my friend Mr. Morgan (vol. xii. p. 86), and the more so as, after reading his letter very carefully, I am not sure that I quite comprehend them even now. Your reviewer is no doubt able to reply for himself: but it certainly seems to me not remarkable that both he and I should have been led into error. Indeed, I do not exactly understand whether Mr. Morgan intends to say that we have misapprehended his views in supposing that in his opinion one of the two great systems of classification of relationships is "arbitrary, artificial, and intentional." Mr. Morgan admits that he himself used these terms in several places. There are, he says, "three or four places, and perhaps more, in that volume in which I speak of the system of a particular people as 'artificial and complicated,' and as 'arbitrary and artificial,' without the qualification in each case which should, perhaps, have been inserted." Thus your reviewer and I were, as he himself allows, using his very own words, though I shall of course omit them if my book should reach a fourth edition.

Moreover, these descriptive epithets are not used casually, but form the very basis of his argument. For instance, in p. 469 he says:—

"It may be remarked, however, that if the system is to be regarded as exclusively natural and spontaneous, the argument for unity of origin would be without force; since, as such, it would be the form to which all nations must insensibly gravitate under the exercise of ordinary intelligence. But if to reach the descriptive system these families have struggled out of a previous system, altogether different, through a series of customs and institutions which existed antecedently to the attainment of the state of marriage between single pairs, then it becomes a result or ultimate consequence of customs and institutions of man's invention, rather than a system taught by nature." *

But then, as I understand, he alleges that a different theory is given in his concluding chapter. So far, however, from finding in that chapter any indication of a change of opinions, I see that he reiterates the same view. After discussing the classificatory system, he says: "There would seem to be but four conceivable ways of accounting for the joint possession of this system of relationship by the Turanian and Ganowánian families; and they are the following:—First, by borrowing from each other; secondly, by accidental invention in disconnected areas; thirdly, by spontaneous growth in like disconnected areas, under the influence of suggestions springing from similar wants in similar conditions of society; and fourthly, by transmission with the blood from a common original source." †

After negativing the two first hypotheses, he proceeds to discuss the third, namely, that of "spontaneous growth under the influence of suggestions springing from similar wants in similar conditions of society." This possible theory, he says, "has been made a subject of not less careful study and reflection than the system itself." But after a patient analysis and comparison of its several forms, he comes to the conclusion that it is insufficient to account for the facts.

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* Morgan's "Systems of Consanguinity and Affinity of the Human Family," p. 469.

† Ibid. p. 500.

Thus, as it seems to me, he clearly repudiates the theory of spontaneous growth.

Mr. Morgan thinks that his solution of the problem of relationships must have escaped my notice, because I did not discuss it in my paper read before the Anthropological Institute; but in that memoir I quoted from the chapter in question, and went on to say—

"Mr. Morgan admits that systems of relationships have undergone a gradual development, following that of the social condition; but he also attributes to them great value in the determination of ethnological affinities. I am not sure that I exactly understand his views as to the precise bearing of these two conclusions in relation to one another; and I have elsewhere given my reasons for dissenting from his interpretation of the facts in reference to social relations."

Thus I expressly pointed out that Mr. Morgan, while characterising the "classificatory" system, to use his own terms, as "arbitrary and artificial," nevertheless also regards it as having "undergone a gradual development following that of the social condition." Surely Mr. Morgan must have written his letter without having my book by him, for it seems to me that the above passages, taken together, represent his own theory, as given in his letter. Mr. Morgan hints that the conclusions contained in his last chapter had escaped my notice. He appears to have overlooked the fact that I quoted from that very chapter. I was not, however, reviewing his work, and differing fundamentally, as I do, from the conclusions adopted by him, while feeling deeply also the great obligations to him under which ethnologists lie, I preferred to state my own views rather than to dwell on the differences between the conclusions at which he and I have arrived. JOHN LUBBOCK

Down, Kent, June 7

Attraction and Repulsion caused by Radiation

I DID not intend to reply to Prof. Osborne Reynolds' letter in NATURE, vol. xii. p. 6, but some persons expect me to say something about it. If the Professor would be careful not to answer me with the ideas that occur to him as he is "on the point of sending off the paper" (see Phil. Mag., Nov. 1874), he would save himself the trouble of many explanations. After my thousand experiments it is scarcely respectful to try to overcome all by his few, and, after three years of my thought, rather hasty to tell me that he explained it all so suddenly with perfect certainty, and that I am unable to comprehend him. It is also scarcely wise to lead us to infer that probably he cannot explain the whole, but that he knows somebody who will soon do it.

Prof. Reynolds seems to base his calculations on some of my experiments which dealt with a perceptible amount of gas, and has not taken notice of those where there is no amount of gas known to be present; for example, in a chemical vacuum.

Prof. Reynolds must show that there is gas or vapour remaining, and he must also show that there is enough to produce the mechanical results. He tells us that the forces will increase as the density of the gases diminishes. The speed will, but if the force does, that can only be up to a certain point, when it is equally certain that a change will take place, and the motion of the particles or molecules will be attended with less force according as they diminish in number. The opposite to this involves something not intended. I suppose he does not intend to speak of forces without matter. The analogy with sound is not quite happy, as that is so readily diminished by lower pressure; although the speed is the same, the power is small. Besides this, what will he say to the case where there is no heat and only light? I am abundantly willing to allow molecules and forces, but I see no place for such as I have been acquainted with.

I am working at the subject and shall be glad to come to a true conclusion. Scientific men need not be so very much afraid of a new law of nature, for some are wanted, and there are certainly many yet waiting to be discovered before nature becomes intelligible to us.

I by no means deny that the phenomena are connected with molecular movements, but I believe that Prof. Reynolds has neither explained this nor proved it by experiment. His explanation suits only a part of my work; and so does the saying that the "experiments stand in much the same relation to the kinetic theory of gases that Foucault's pendulum occupied with regard to the rotation of the earth." This is an analogy showing much acuteness, viewing the matter from what I consider the unproved side.

Prof. Reynolds goes far when he says that my experiments are "the only direct proof that has ever been obtained of the kinetic theory of gases." It may be, but if so, physicists must have been too easily pleased with their theories.

I might say much more, but I prefer to wait. There is but little good done by short notes when such a large and important subject waits for elucidation. WILLIAM CROOKES

London

American Indian Weapons

THE Pai-ute weapon, described by Mr. Mason in your last number (p. 107), although extremely interesting and quite new to me, appears scarcely sufficiently characteristic of a war weapon to form an exception to the statement of Schoolcraft, that the clubs of the North American Indians as a rule are curved. It would be interesting if it could be ascertained how such a peculiar instrument as that described by your correspondent came to be used as a weapon of war. Its form precludes the possibility of its having been designed for such a purpose. The mode of holding it suggests the idea of its having originally been used as a pounder, the thick end having perhaps been employed for pounding grain, beating out grass for cloth, or for preparing skins. It somewhat resembles the instrument used for making bark cloth in some of the Polynesian Isles, and it corresponds to the Beatle (Battelle) still used by Irishwomen for beating flax, and occasionally, I have no doubt, as a weapon of war; but these are used with the flat side, not the end. The only weapon I know of that is used like the Pai-ute club is the New Zealander's Merai or Pattoo-Pattoo, the sharp end of which is thrust into the back of the head of the offender; and I have suggested elsewhere that this peculiar and awkward mode of using it arose from its having been originally what its form resembles, a stone axe blade (celt), used as the Australians now use it sometimes, in the hand without any handle. The sharp edge at the end of the Merai shows its original intention, in the same way that the flat end of the Pai-ute club could never have been designed as an offensive weapon, but would have been useful as a pounder; it may be, in fact, a "survival" converted to other uses. There exists, of course, no law of nature to prevent North American Indians from using straight clubs as well as curved ones, but my observation of their weapons confirms the statement of Schoolcraft, that as a rule they do not. Amongst races in a more primitive state of culture, as amongst the Australians, we find that nearly every form of club that is made straight is used also in a curved form, the curvature arising merely from the natural bend of the branch out of which it was constructed; when these natural curves were found useful, they appear to have been retained and systematised. But the North American weapons are of a more advanced and conventionalised description, and we cannot trace their origin and *growth* so clearly as amongst lower savages. The description of the Moquis boomerang by Mr. Mason is an interesting fact, which, combined with the mention of it by Bancroft amongst the Pueblo Indians of New Mexico, points to the probability of a connected area of distribution. Drawings of weapons such as those given in your journal are of the utmost value in assisting to trace the distribution of like forms. A. LANE-FOX

Guildford, June 12

Hardened Glass

PERHAPS the following short and preliminary account of some observations on the optical and mechanical properties of De la Bastie's toughened, or, as I think more correctly, hardened glass, may interest your correspondent Mr. James H. Logan (vol. xii. p. 87).

Immediately after the publication of M. De la Bastie's specification I prepared specimens of the glass, I submitted them to careful optical examination by polarised light. Perhaps the best experiments are those made by means of short cylinders and small cubes and parallelopipeds carefully "hardened." A small cube with half-inch sides thus prepared has its sides ground plane and polished. The operation of polishing may be dispensed with if a small microscopical thin cover be cemented on the ground surface with Canada balsam. The cube is then mounted between strips of blackened cork, and examined in the usual way by means of Nicol's prisms, glass plates or other appropriate polariscope. The beautiful chromatic phenomena thus brought out at once indicate that amongst the causes which operate to produce the hardness of glass, powerful compression of the interior by the contracting exterior must be one. The phenomena are, in fact, essentially those of compressed glass, and the curves of colour, or black and yellow, seen when the glass is examined by white or monochromatic light, indicate successive curves of tension and balanced, or no-tension. In a carefully prepared glass rod of half-inch length these curves are rings traversed by a well-marked black cross. In an oval the rings assume the character of those seen in biaxial crystals. When plates are examined, the light being transmitted from back to front, they appear to act essentially as bi-refracting plates, but with crosses and bands somewhat irregularly distributed, and capable of being referred to the angles of the plates or to centres of unequal heating.

My experiments on the mechanical properties of the glass have chiefly been confined to testing its hardness and the possibility of grinding it. So far as I have gone at present I make it to be nearly twice as hard as ordinary glass, which it scratches with ease. It can be cut with a good file well moistened with turpentine, and can be ground on a stone with sand, without fracturing, if great care be taken and the glass be well prepared. One piece, which manifested when under the polariscope evidences of ill-balanced tension, the neutral line lying near one surface, submitted to transverse grooving, but disintegrated on being ground on one surface as soon as the outer surface had been ground away to near the neutral line. There appears to be an easily reached limit beyond which the surfaces must not be unequally removed, but as my friend Mr. Thos. Fairley, F.R.S.E., has been good enough to show me, there is practically no limit beyond which *both* surfaces may not be *simultaneously* removed. This result, foretold by me from polariscopical analysis, Mr. Fairley has kindly shown by dissolving the opposing surfaces away by hydrofluoric acid. The least hard portions dissolved much more readily than the thoroughly hardened, and the etched surfaces show wavy lines closely following the tension lines shown by the polariscope. There is further this remarkable feature, that the inner portion of the glass proves to be essentially common glass, which fractures in the ordinary way. Further experiments are necessary for the complete elucidation of the subject, and are in progress, but the preceding may be useful to fellow-workers on the subject.

Leeds, June 12 HENRY POCKLINGTON

The House-fly—A Query

IN one of the rooms in the Science Schools lately built here, I have noticed, in the last week or so, great numbers of the large house-fly (*Musca domestica*) lying dead on the floor. Last Tuesday I saw one fall dead, but this is the only one. This morning I counted thirty-two in a space of about three square yards. I examined one under a microscope, and found that most of the small hairs on its body were covered with a yellowish powder. Can any of your readers give me any explanation of this?

Harrow, June 8 HARROVIAN

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—Mr. J. E. Gore (Umballa, Punjâb) writes, under date May 5, that he believes 27 Canis Majoris to be a variable star. It is 4 in Harding's Atlas, but at present about 5½ or 6, and much inferior to 28 in the same constellation, which Harding rates at 5. The change of brightness was first noticed in 1874. This star is 4·5 in the Radcliffe Catalogues, 5 in Arg. Zones, 5½ in Lacaille, and 6·5 in Heis's Catalogue; Behrmann has 6, and the lowest estimate of magnitude is 7, in Flamsteed's Catalogue, with respect to which Baily remarks that there is no magnitude recorded in the original observation-book, and that modern observations make it 4½. Mr. Gore states he has also "suspected some variation of light in the red star 22 Canis Majoris (between δ and ε); it is usually rated as of magnitude 3 or 3½, but for some time past it has seemed rather fainter than an ordinary star of the fourth magnitude." Bradley and Piazzi have this star 3·4, Flamsteed, Brisbane, and Heis, 4, the Washington General Catalogue 5, and it is so rated once by Argelander; in Behrmann it is 4·5.

We will take this opportunity of directing the attention of our astronomical readers in the southern hemisphere to Behrmann's valuable Atlas and accompanying Catalogue, which, pending the publication of Dr. Gould's Cordoba "Uranometria," is the only real authority for recent magnitudes of the naked-eye stars of the southern heavens. It is entitled "Atlas des Südlichen Gestirnten Himmels, von Dr. Carl Behrmann" (Leipsic, 1874), and contains the stars in forty-six constellations between 20° of south declination and the south pole, and is arranged upon the plan of Argelander's well-known work. The number of stars included in the Atlas is 2,344. It was formed by Behrmann in the short space of from nine to ten months, beginning in the autumn of 1866, and on that account, as the author remarks, there may probably be some omissions and errors, but it is nevertheless a very meritorious and important work. It appears, from Dr. Gould's report to the Minister of Public Instruction of the Argentine Republic, that his "Uranometria" has undergone the intended revision, and is now completed, and that steps are being taken for its publication. It is only one of the extensive scientific undertakings which will mark the residence of this distinguished and energetic astronomer at Cordoba.

THE BINARY STAR η CORONÆ BOREALIS.—Mr. Wilson, Temple Observatory, Rugby, has published some remarks upon the tendency of recent measures of this star to shorten the period of revolution assigned by computers hitherto, and refers to Winnecke's careful discussion of the measures to 1856. Winnecke's orbit, however, is not the latest that has been calculated, that of Wijkander including measures to 1870, and the period he finds, 41·58 years, is not much different from that which Mr. Wilson considers to be required by the more recent measures. Still, these later observations point to a further diminution of the period, the exact amount of which may probably be soon determined. The following angles and distances are calculated from Wijkander's orbit, and on comparison of the former with the results of observation, it will be found that the computed value is now about 3° behind the true one.

1872·0	Angle	48°·07	Distance	0″·90
73.0	,,	51 ·98	,,	0 ·86
74.0	,,	56 ·35	,,	0 ·81
75.0	,,	61 ·32	,,	0 ·76
76.0	,,	67 05	,,	0 ·70

This orbit gives the angle too small by 5°·3 for Sir W. Herschel's measure in 1782, and also too small by 4°·3 for his measures in 1802, or, if these differences are expressed in the form Δ sin. *d* P, −0″·09 and −0″·04 respectively.

Sir W. Herschel's description of his experience with this star is found in *Philosoph. Trans.* 1804. On Sept. 9, 1781, the position was 59° 19′ *n.f.*, and on Sept. 6, 1802, by "a mean of two very accurate measures" it was 89° 40′ *n.p.* (This is now found to require correction of 180°.) Herschel further states "the distance of the two stars has not been subject to any sensible alteration. Sept. 9, 1781, a very small division might be seen with 460. Aug. 30, 1794, they were so close that with a 10-feet reflector and power of 600 a very minute division could but just be perceived. April 15, 1803, with a 10-feet reflector, a very small division was also visible, with 400, though better with 600. And May 15, 1803, I saw the separation between the two stars with the same 7-feet reflector and magnifying power of 460, with which I had seen it twenty-two years before." We have from Wijkander's orbit for comparison with this account:—

1781·69	Angle	25°·4	Position	0″·98
1794·66	,,	80 ·2	,,	0 ·60
1802·68	,,	175 ·5	,,	0 ·57
1803·37	,,	181 ·6	,,	0 ·59

Except in 1781, it will be remarked, the distances at the dates of Herschel's observations are given sensibly the same.

PROPER MOTION OF B.A.C. 793.—Prof. C. P. Smyth has lately drawn attention to an apparent variation in the amount of proper motion of the star B.A.C. 793, shown by the Edinburgh observations between 1837 and 1868, involving a diminution in the motion in R.A. and an increase in that in N.P.D. The star is No. 31 of the list included in Argelander's *Untersuchungen über die Eigenbewegungen von* 250 *Sternen*, Bonn Observations, Vol. vii., Part I., where, from a rigorous discussion of seventy years' observations, the proper motion in R.A. is found to be + 0·1245s, and that in N.P.D., − 1″·456. The comparison of the normal place for 1855·0 with the whole course of published observations to 1865, in which every refinement of calculation is introduced and the above proper motions employed, with Bessel's precession-constants, does not afford any indication of the variability of proper motion suspected by Prof. Smyth. The last Edinburgh observations in 1866 and 1867 show a difference from Argelander's formula of only − 0·08s. in R.A., and agree exactly with the N.P.D. The Washington position, depending upon two observations towards the end of 1870, is in close agreement with Argelander in R.A., and differs − 2″·0 in N.P.D. If a position of the star depending upon a good number of observations should be obtained during the present year, the point may be definitively settled, but thus far variation of the proper motion appears to be at least questionable. Upon this subject see Bonn Observations as above, pp. 20, 54, and 109.

MINOR PLANET NO. 146.—The number of small planets is rapidly approaching *one hundred and fifty*. M. Borrelly, of the Observatory at Marseilles, announces his discovery of No. 146 on the evening of June 8. At 10 P.M. its place was in R.A. 17h. 20m. 16s., and N.P.D. 111° 20′ 15″; it is as bright as stars of the eleventh magnitude, and therefore for the present should be readily identified by means of Chacornac's Chart No. 52.

SCIENCE IN GERMANY

(*From German Correspondents.*)

HERR VON BEZOLD, of Munich, has published some interesting researches on the periodical changes in the frequency of thunderstorms during long periods of time. These researches are particularly noteworthy for the original manner in which the author has used the statistical materials on thunderstorms which he could obtain (principally within the kingdom of Bavaria). As the character of our reports will not permit us to give details with regard to the manner of treatment, we pass at once to the results which Herr von Bezold has arrived at.

First of all it was found that the frequency of thunderstorms during a long period is generally either on a continuous increase or decrease, and that these variations are periodical.

If we ask on which other meteorological phenomena these variations could possibly depend, the first thing to be considered is the temperature. It is further advisable, on account of the numerous relations that have lately been discovered to exist between sunspots and meteorological phenomena, to turn attention also in this direction. It has been found in reality, that if we represent the variations of the frequency of thunderstorms by a curve and compare the same with the curve of the frequency of sunspots, the minima of the thunderstorm curve coincide exactly with the maxima in the sunspot curve. On the other hand, the thunderstorm curve forms, to a certain extent, the mean between the sunspot curve and the curve of the deviation of the average yearly temperature for our latitudes.

We must observe here that although the path of the thunderstorm curve shows a general and unmistakeable connection with that of the sunspot curve (so that, for instance, for the period from 1775 to 1822 the maxima of the thunderstorm curve coincide almost completely with the minima of the sunspot curve), yet the details of the thunderstorm curve coincide better with the details of the curve of temperatures, so that nearly every rise or fall in the latter can be distinctly traced in the former. This connection between thunderstorms and the deviations of the yearly temperatures from the total average, shows itself still clearly, even where that between the thunderstorm and sunspot curves is less apparent.

Herr von Bezold recapitulates the results of his investigations as follows:—High temperatures, as well as a solar surface free from spots, cause a greater number of thunderstorms during a year than the reverse. Now, as the maxima in the frequency of sunspots coincide with the maxima of the intensity of aurora borealis, it follows that both groups of electrical phenomena, thunderstorms and auroræ, complement each other, as it were, so that in years with many thunderstorms auroræ will be rare, and *vice versâ*.

From this connection between sunspots and thunderstorms an immediate electric action between the earth and the sun does not necessarily follow, but it may be simply a consequence of the magnitude of insolation, which depends on the frequency of spots. These changes in the insolation are not felt simultaneously but successively in the different latitudes. The phenomena of thunderstorms, however, do not only depend on the conditions of temperature at a given locality, but also on the state of the atmosphere at far distant points, belonging to another zone; and this is most evident with thunderstorms accompanying strong currents of wind or tempests. In this manner the peculiar intermediary position which the thunderstorm curve occupies between the curves of temperature and sunspots might perhaps find its explanation eventually.

IN zoological investigations experiments are rare, and therefore the results obtained by them are all the more valuable. The latest work of this kind—"Researches on the Theory of Descent: I. On the Season-dimorphism of Butterflies," by Dr. August Weismann, Professor at Freiburg—will, however, interest not only the narrower circle of entomologists, but also the amateurs in this branch of science, as it will furnish them with a sort of guide for the pursuit of their hobbies in such a manner as to do great service to science. Weismann bases his researches on the fact, which has been known for some time, and which has been called "season-dimorphism" by Wallace, that certain butterflies, when issuing from their winter chrysalis in the spring, show a different coloration and design upon their wings than do those which appear in the following summer; so that until this fact was discovered, the two forms were thought to be two distinct species of butterflies. We will only mention one of many examples, as it refers to one of the commonest kinds of day-butterflies. *Vanessa levana* is only the winter form of *Vanessa prorsa*, which is the summer form produced by the former; the latest offspring of the latter, which survive the winter, reappear as *Vanessa levana* in the following spring. Weismann exposed the caterpillars produced by *V. levana* in May, which in the normal state should have produced the imago of *V. prorsa*, to a continuous temperature of 0° − 1° C., after they had changed to nymphæ. The result was that they yielded the winter form *V. levana*, with few exceptions. The same result was obtained with the second summer generation, which under ordinary conditions would still have appeared as *V. prorsa*. On the other hand, Weismann succeeded only very rarely in forcing the last generation in the year again to take the *Prorsa* form, by keeping the nymphæ in hothouses at 15° − 30° C., instead of in the ordinary winter temperature. Most of the nymphæ passed the winter even in hothouses or in heated rooms, and produced *V. levana* in the spring. Similar researches were made by Weismann with another common day-butterfly species, *Pieris napi*.

Weismann thinks that the winter form of these butterflies was the original one, which existed alone and in a single annual generation in Europe, during the so-called ice period. As the summers became longer and warmer, a second and finally a third annual generation could be produced, and these were changed to the *Prorsa* form by the higher temperature. The return of the colder season then always caused a return to the original form (*Atavism*), just as it occurred in the experiments. To confirm this view, Weismann quotes the fact that in Lapland and in the upper Alps only a winter form of *P. napi* exists. As with an incomplete return to the original form intermediate forms result, the varying aspects of which prove that the change of the original form always takes place in a certain direction, Weismann thinks that the change of temperature might certainly have given the impulse for a change of form, but that the particular direction of the same lies in the constitution of the animal in question. We may certainly consider as a result of these investigations, that a change of climate, together with other causes, may have directly produced a great number of different species of butterflies.

Another fact mentioned by Weismann refers to the above, and is no less interesting. There is one of the lower Crustaceæ, *Leptodora hyalina* (Siebold's and Kölliker's *Zeitschrift für Wissenschaftliche Zoologie*, 1875), which is remarkable in many ways. This animal, according to the observations of the Norwegian Sars, shows similar phenomena, as the winter breed is differently developed from the summer breed, although the perfect forms are not so widely different as those of the butterflies.

ZOOLOGICAL NONSENSE

NOT many months since a controversy which had been raging for several weeks in the columns of the so-called "leading journal" was suddenly and completely put an end to by a well-known writer in a contemporary calmly and dispassionately pointing out that both disputants had been uttering what was absolute nonsense. "I use the word nonsense," he went on to say, "not as it is often used as a vague term of disapproval, but with a strict specific meaning, as contradistinguished from sense. All words—all articulate words—must be either sense or nonsense. They are sense if their meaning can be imagined, conceived, represented in some way or other to the mind. They are nonsense if their meaning cannot be imagined, conceived, or represented in any way to the mind. When a man says, 'I saw six men and two women walking down such a street, dressed in such a way, and heard them talking on such a subject,' anyone can understand, whether he believes it or not. The speaker is talking sense, whether truly or falsely. If he were to say he saw two crooked straight lines standing in the five corners of a square, you would say he was talking nonsense, that his words were neither true nor false, and that he might as well keep silence, or utter any other unmeaning sounds. The difference between these two examples consists solely in this, that the first assertion can, whereas the last cannot, be pictured to the mind. Each particular word by itself is as clear in the one case as in the other."

What the question then under discussion was, does not signify. Enough that it was nothing which had to do with natural science. But we are sorry to say that nonsense is still occasionally spoken or written by those who, if they do not exactly profess to be scientific, yet pretend to treat of things that clearly belong to the domain of science, and so make some approach to that character. Moreover, they are looked up to by some well-meaning though imperfectly instructed persons as authorities worthy of consideration. There was a time when there was a good deal of nonsense written by naturalists, and especially by zoologists, but we had been in hopes that the practice was entirely given up. It seems, however, that we are disappointed. Here is a melancholy instance to which our attention has lately been called:—

"I have never seen any reason to doubt, *first*, that the Vertebrata, or more properly 'Endosteata,' are the central group of the animal kingdom, the others being the Exosteates (or Articulates), the Anosteates (or Molluscs), and the Actiniates (or Radiates); *secondly*, that the Sucklers are the central group of Endosteates, the other groups being Birds, Reptiles, and Fishes; the Sucklers are connected with Birds through the Bats, with Reptiles through Pangolins and Armadillos, and with Fishes through Porpoises and Whales. The pectoral sucklers (Primates) are central, and MAN is the centre of these—not a mere unit on the circumference of the system."

There is no need to name the writer of this passage or the publication in which it appeared within the last few weeks, because our business is with the matter, not with the man, though we can hardly do otherwise than marvel at his style of easy assurance—"I have never seen any reason to doubt." We at first almost fear a platitude, then catching a glimpse of what is coming, we begin to think we are on the verge of a great discovery, or perhaps shall be brought face to face with intelligence itself. Sad is our disappointment as the sentence proceeds. The unwonted word "Endosteata" jars our bones within us, but we recover as we best can, and so far suppose it is all right; the expression of a "central group" may pass as a metaphor, and we feel a sense of relief and obligation at having the extraordinary names of the other groups translated for us; but then we thought we had somewhere been taught the Radiates had no existence. However, we hail a friendly semicolon, and find that we are arrived at the end of the author's first article of faith, which, though obscured by the metaphor, is yet intelligible. Now, then, for his "secondly." The word "Sucklers" strikes us as singular, but we discover that whatever it means forms another "central group," this time of "Endosteates"; so, to meet metaphor by metaphor, we exclaim "wheels within wheels," and it is a comfort to find that the surrounding groups are our old friends Birds, Reptiles, and Fishes; Amphibians, we suppose, being packed between the two latter. The next part of the sentence, however, is absolutely shocking: "Sucklers" connected with Birds through Bats, with Reptiles through Pangolins and Armadillos, and so on. Why, what is a zoological connection? Is it of affinity or analogy? Can the author have ever seen or examined the structure of the animals he mentions? We are taken back to the dark ages of zoology, if not to ages almost prehistoric. Needless to say that our confidence is gone. Then we have the concluding sentence with the old metaphor once more, and a new one; or is it that no metaphor is intended after all? that these concentric circles forming a system with a circumference on which man is *not* a unit—we wonder who ever said he was—exist in the author's mind? In our own we are free to say they do not. We are sure that they do not exist in nature, and we are so unimaginative that we cannot picture a representation of them to ourselves. Accordingly there is no help for it but to conclude that all this is clear, unmistakable, undeniable nonsense, as much so as the two crooked straight lines standing in the five corners of a square. These "circles," with their unit-bearing circumference, are, in the words of the writer from whom we first quoted, "the nonsensical shreds of exploded metaphysics"—relics of that silly "circular system" with its mystical numbers, its fives or its sevens—the will-o'-the-wisp of fancy that once led men's minds astray from the path where only they could find the truth they were earnestly seeking.

Those who desire to believe nonsense at all hazards and in the face of the clearest possible proofs, and indeed like it rather the better because it is so, can of course continue in their fool's paradise. Who can doubt that they see the paragon of animals in the author of the passage we have been criticising, and that he sits at the centre—the "focal point" is the choice expression, we believe—of a select circle of admiring "pectoral sucklers" the very "hub of the universe," as our American friends might say? The Report of the last Local Examination Syndicate of one of our Universities speaks of Zoology as follows:—"The general character of the work in this subject is, perhaps, even worse than it was last year. In many cases the teaching appears to have been faulty or defective; there was a general ignorance of the principles of zoological classification; and a great number of candidates sent up answers so full of confusion and error as to lead to the opinion that they had only prepared for the examination by a hurried attempt to learn portions of a text-book by rote." Who can wonder at this prevalent "ignorance of the principles of classification" when a zoologist in a position to give instruction to youth and encourage their devotion to the study of nature utters absurdities such as we have just been noticing? We fear that he is not alone in his mischievous folly.

LECTURES AT THE ZOOLOGICAL GARDENS*

VII.

June 10.—*Prof. Mivart on Kangaroos.*

AFTER pointing out the external and osteological characters of the Kangaroo, the lecturer proceeded to consider the question, What is a Kangaroo? what its place in the scale of animated beings; as also its relations to space and time? At birth the Kangaroo is strangely different from what it ultimately becomes. It is customary to speak of the human infant as exceptionally helpless at birth and after it, but it is at once capable of vigorous sucking, and very early learns to seek the nipple. The great Kangaroo, standing some six feet high, is at birth scarcely more than an inch long. Born in such a feeble and imperfect condition, the young Kangaroo is not able to suck of its own accord. The mother places it on one of the nipples and squeezes its own milk-gland by means of a muscle which covers it, in such a way that the fluid enters the mouth of the young one. In most animals, man included, the air-passage opens into the floor of the mouth behind the tongue, and *in front* of the opening of the gullet. Each particle of food as it goes towards the gullet passes over the entrance to the windpipe, but is prevented from falling in by the action of the epiglottis, which stands up in front of the opening and closes over it when food is passing. But in the young Kangaroo, the milk being introduced, not by any voluntary act of the recipient, but by the action of the mother, it is evident that some special mechanism is necessary to prevent choking. This is found in the elongation of the upper part of the windpipe, which projects up into the nasal passage, and is embraced by the soft palate in such a manner that the food passes on each side of it, whilst the air does not enter the mouth at all.

The Kangaroo browses on the herbage and bushes of more or less open country; and, when feeding, commonly applies its front limbs to the ground. It readily, however, raises itself on its hind limbs and strong tail, as on a tripod, when any sound, sight, or smell alarms its natural timidity. Mr. Gould tells us that the natives sometimes hunt them by forming a great circle around them, gradually converging upon them and so frightening them by cries that they become an easy prey to their clubs. The Kangaroo is said to be able to clear even more than fifteen feet at one bound. It breeds freely in the Society's Gardens, many being reared to maturity. They have been also more or less acclimatised in the grounds of Glastonbury Abbey, in the parks of Lord Hill and the Duke of Marlborough, and elsewhere.

It is just upon one hundred and five years since the Kangaroo was first distinctly seen by Englishmen. At the recommendation and request of the Royal Society, Capt. (then Lieutenant) Cook set sail in 1768, in the ship *Endeavour*, on a voyage of exploration, and for the observation of the Transit of Venus of the year 1769. In the spring of the following year the ship steered from New Zealand to the eastern coast of New Holland, visiting, among other places, Botany Bay. Afterwards, when detained in Endeavour River, an animal as large as a greyhound, of a slender make, a mouse colour, and extremely swift, was seen more than once. On July 14, "Mr. Gore, who went out with his gun, had the good fortune to kill one of these animals," adding, "This animal is called by the natives *Kangaroo*." Kangaroos, however, had been seen by earlier travellers, and these may even be the animals referred to by Dampier when he tells us that on the 12th of August, 1699, "two or three of my seamen saw creatures not unlike wolves, but so lean that they looked like mere skeletons."

The whole animal population of the globe is termed the Animal Kingdom, in contrast with the world of plants, or Vegetable Kingdom. The highest sub-kingdom of this is that of the Vertebrata, of which the Mammalia form the highest class, to which class the Kangaroos belong. Of these animals there are many species arranged in some four genera; the true Kangaroos forming a genus, *Macropus*, which is very nearly allied to three others, namely, *Dorcopsis*, with a very large first grinding tooth; *Dendrolagus* (Tree Kangaroo), which frequents the branches of trees, and has the fore limbs but little shorter than the hind; and *Hypsiprymnus* (Rat Kangaroo), which has the first upper grinder compressed and vertically grooved. The species all inhabit Australia and the adjacent islands. They all agree in having the second and third toes slender and united in a common fold of skin; the hind limbs longer than the fore limbs; no inner metatarsal bone; all the fore toes provided with claws; and six upper together with two lower incisors. These five characters coexist in no other animal.

The family Macropodidæ is one of six which, together with it, make up the larger Kangaroo Order, the exact relations of which necessitate a cursory view of the others being taken. The Bandicoot plainly differs from the Kangaroo in external appearance, but resembles it in having the hind limbs longer than the fore, and also in the structure of the hind feet, which are similarly modified, but to a less degree, a rudimentary inner toe being present. It is an example of the family Peramelidæ, one member of which, *Chœropus*, is very exceptional, in that the hind toes, except the fourth, are exceedingly reduced and functionless, at the same time that its anterior digits are only two in number. The Phalanger is a type of the Phalangistidæ, arboreal, nocturnal animals, in which the limbs are of nearly equal length, with the second and third hind toes united, and a large opposable thumb. Some have prehensile tails, others expansions of the skin in the flanks to act as a parachute in leaping. The Koala (*Phascolarctus*) and *Tarsipes* are aberrant members; the former without a tail, the latter with minute and few teeth. The genus *Cuscus* is found in New Guinea and Timor. The Wombat (*Phascolomys*) forms a distinct family. It is a burrowing, nocturnal animal, the size of a badger, with a rudimentary tail, as well as peculiar feet and rodent-like teeth.

The Dasyuridæ, or family of the native cat, wolf, and devil, are so called from their predatory and fierce nature. They have large canine teeth and sharp molars. The second and third toes are no longer bound together, whilst the great toe is absent or small. Myrmecobius is a peculiar genus, remarkable for the great number of its back teeth. The Tasmanian Wolf is confined to that island, and will very probably soon become quite extinct, because of its destructiveness to the sheep of the colonies. It differs from all other members of the Kangaroo order in that cartilages represent the marsupial bones found in every other member of the order. The last family consists of the true Opossums, which differ from all above referred to in inhabiting America only, not Australia. They are called Didelphidæ; one species is aquatic in habit, and web-footed.

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* Continued from p. 114.

Such are the very varied forms composing the six families which together make up the Kangaroo order. What is its relation to those of the other Mammalia? Very noticeable in it is the very great diversity of form, dentition, and habit found in the order, some being arboreal and vegetarian, others terrestrial and carnivorous, &c.; nevertheless, these so varied marsupial forms possess in common important characters by which they differ from all other mammals. These characters, however, relate mainly to the structure of their reproductive organs, as to the great importance of which characters naturalists are agreed. The angle of the lower jaw is also peculiar. Almost every mammal which has marsupial bones has the angle of its jaw inflected, or else has no angle at all, whilst every animal which has both marsupial bones and an inflected jaw-angle, possesses also those other special characters which distinguish the marsupials from all other mammals. We have, therefore, at least two great groups, one non-marsupial, containing man, the apes, bats, cats, hoofed beasts, &c.—the Monodelphia; the other containing the marsupials only—the Didelphia. There is a third group containing only the Ornithorhynchus and Echidna, which form by themselves alone a third group, Ornithodelphia.

As to its zoological relations, we may therefore say that the Kangaroo is a peculiarly modified form of a most varied order of Mammalia (the marsupials), which differs from all ordinary beasts (and from man) by very important anatomical and physiological characters, the sign of the existence of which is the coexistence in it of marsupial bones with an inflected angle of the lower jaw. As to the geographical relations of the Kangaroo, a study of their distribution over the world shows that the Kangaroo is one of an order of animals confined to the Australian region and America, the great bulk of the order, including all the Macropodidæ, being strictly confined to the Australian region.

The lecturer concluded by explaining the geological relations of the Kangaroo and its order, pointing out that in Australia we have an instance of zoological "survival" connecting the existing creation with the triassic period.

*MAGNETO-ELECTRIC MACHINES**

II.

IN 1871 M. Jamin communicated to the French Academy of Sciences a short note by M. Gramme, on a magneto-electric machine which gave electrical currents always in the same direction by the revolution of an electro-magnetic ring between the poles of a permanent magnet. The construction of the electro-magnetic or ring armature in Gramme's machine differs in some mechanical details from that of the transversal electro-magnet of Pacinotti, and the serious mistake of applying the rubbers which carry off the current at the wrong place is avoided. We must therefore regard the Gramme machine as the first effective magneto-electric machine constructed to give continuous currents all flowing in the same direction. Before entering into the details of its construction it may be useful, even at the risk of some repetition, to describe as briefly as possible the principles on which the action of the electro-magnet or ring armature depends.

In its simplest form this armature consists of a ring of soft iron, round which is wound a single closed coil of copper wire or other metallic riband, covered with silk, except at a single point in each loop of the coil, which is left exposed in order to make contacts. In Fig. 4 such a ring is shown, placed between the poles of a permanent magnet. The parts of this ring contiguous to the poles N S of the fixed magnet will acquire respectively polarity of the opposite kind to that of the neighbouring pole, while the parts of the ring O O′, at the end of a diameter at right angles to the line joining the poles, will be neutral. If the ring is made of homogeneous metal, this statement will be strictly exact so long as it is at rest, but if it be made to revolve rapidly on an axis perpendicular to the plane of the fixed magnet, the poles of the ring, as well as the neutral points, will be slightly displaced, as M. Gaugain has shown, in the direction of the motion. This arises from what is called the coercive power of iron; that is, from the circumstance that even the purest iron will not acquire or lose magnetism in an inappreciably short period of time. The change in the distribution of the magnetism in the ring from this cause is, however, inconsiderable, and may easily be allowed for.

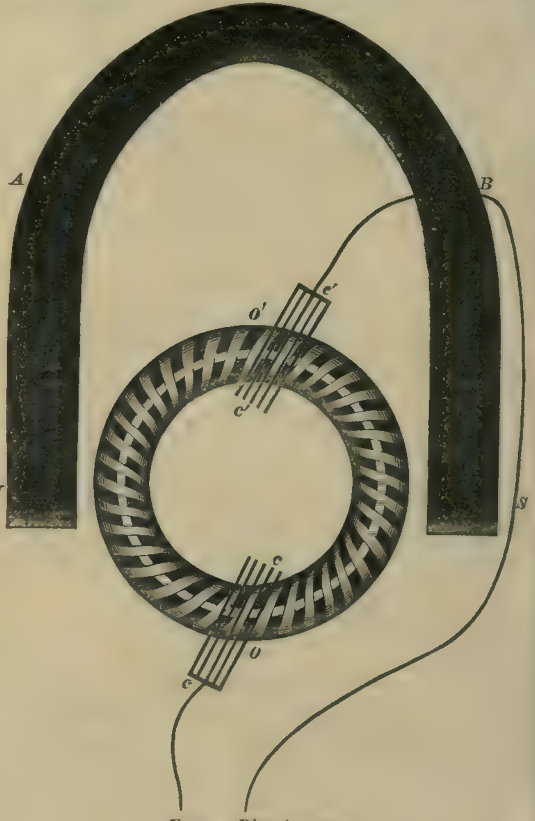

FIG. 4.—Ring Armature.

To make the explanation clearer, let us suppose that there is only one loop of wire, *a* (Fig. 5), upon the ring, and that this loop is moveable and in connection with a galvanometer *g*. If now the loop is moved along the ring (assumed to be at rest) from the neutral line O towards S′, a current will be developed in a certain direction, the intensity of which will increase till the loop reaches S′, after which the current, always preserving the same direction, will diminish till the loop arrives at O′, when the current will for a moment fall to zero, to be succeeded by a current in the opposite direction as the loop leaves O′. This current will in like manner increase during the advance of the loop to N′, when it will attain a maximum, and afterwards diminish till it arrives at O, where, after passing through zero, the direction will again change. There will thus be a current always flowing in one direction as the loop moves from O through S′ to O′, and in an opposite direction as it moves from O′ through N′ to O. Now if the loop, instead of being moveable upon the ring, be firmly attached to it, and the ring itself carrying the loop be rotated on its axis in the plane of the fixed magnet N M S, it will be found that the currents developed will correspond both in direction and intensity with those produced in the moveable loop, provided we allow for the small displacement in the position of the poles of the ring arising from its motion.

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* The substance of a Lecture, with additions, delivered at the Belfast Philosophical Society, March 17, by Dr. Andrews, F.R.S., L. & E. (Continued from p. 92.)

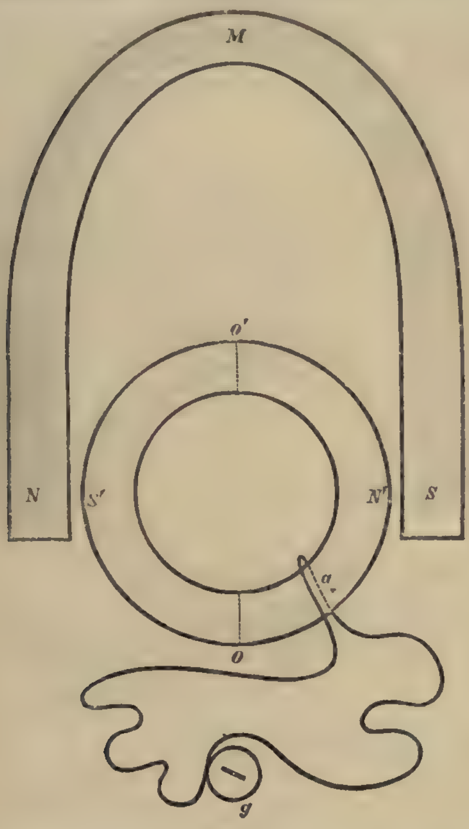

FIG. 5.

The foregoing statement may be extended from a single loop to any number of loops forming part of a coil extending over the whole of the iron ring (Fig. 4). Each loop of such a coil, during one-half of every revolution, will tend to give a current in one direction, and during the other half, a current in the opposite direction, and the electromotive force thus produced will augment with the number of loops in the coil. If, then, metallic conductors, *c c*, *c′ c′*, are applied to the loops (whose surfaces must be exposed at one point for this purpose) as they pass through the positions O and O′, continuous currents, all in the same direction, will be obtained on rotating the ring without the use of a commutator, unless we apply that term (as Pacinotti has done) to the system of conductors or rheophori by which the currents are carried off.

In order to obtain currents of high intensity, the single coil must be replaced, as in similar machines, by a number of coils of thin wire rolled one above the other and carefully insulated. To carry oft the current, these coils must be divided into separate helices, with the adjacent terminals of the wires of the helices in metallic connection, so that the iron ring may be always surrounded by an endless conductor of great length. I have already described the arrangements adopted in the transversal electro-magnet of Pacinotti. The construction of the ring armature in Gramme's machine will be readily understood from Fig. 6, in which it is represented in different stages of its construction, so as to show the manner in which the principal parts are connected.* At A a section of the iron ring itself is shown, composed of a bundle of iron wires; at B B the helices, or bobbins, are seen both in section and detached; and at R R the form is shown of one of the insulated copper conductors, to which the contiguous ends of the wires of the helices are attached, and from which the current is drawn off by means of rubbers or brushes formed of flexible bundles of copper wire. These brushes are so applied at the neutral positions of the ring that they begin to touch one of the conductors R, before they have left the preceding one. In this way no actual break or interruption occurs in the current. The permanent magnets employed in the smaller Gramme machines are on the improved construction of M. Jamin.

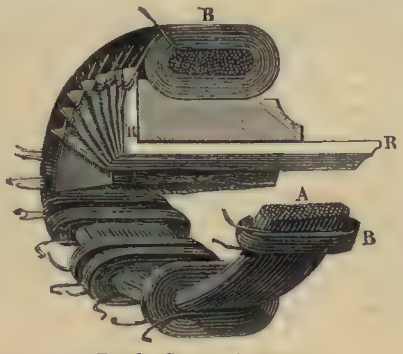

FIG. 6.—Gramme Armature.

With a small machine, on the Gramme construction, very remarkable electrical effects may be obtained. I will give the results of a few experiments which I recently made with one of the two machines exhibited at the late meeting of the British Association, and which are now in Queen's College, Belfast. This machine was able to heat to full ignition in daylight a platinum wire one foot in length, and weighing 12 grains. With a voltameter formed of two slips of platinum foil, exposing each a surface of 1·25 square inches, and at the distance of half an inch from each other, immersed in dilute sulphuric acid, water was freely decomposed. For 100 turns of the machine, the volumes of the mixed gases collected at different rates of turning were as follows:—

In 34 seconds	2·60 cubic inches
„ 45 „	2·53 „
„ 75 „	1·45 „
„ 135 „	0·35 „

From these observations it appears that, under the conditions of this experiment, the quantity of water decomposed for the same number of revolutions of the ring increases quickly with the rate of the motion till a certain rapidity is attained, after which little further change occurs.

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* I take this opportunity of expressing my obligations to M. A. Niaudet-Breguet for his kindness in enabling me to give the admirable figures of the Gramme Machine which illustrate this paper. They first appeared in a short work on the Gramme Machine, recently published by M. Breguet, to which I beg to refer for more detailed information regarding its practical applications ("Machines Magnéto-électriques Gramme." Par M. A. Niaudet-Breguet. Paris, 1875).

An interesting experiment may be made with these machines, which illustrates a well-known dynamical principle, by turning the machine at a steady rate, with the wires for transmitting the current disconnected, and observing the great additional force required to maintain the motion on connecting the wires.

The machine may be converted into an electro-magnetic one by transmitting the current from a voltaic pile through the helices of the iron ring, which will then rotate upon its axis. If the current be supplied by another magneto-electric machine, the same result will be produced, and we shall thus have mechanical force, after assuming the form of current electricity, reappearing, but with some loss, in the form of mechanical force. In an experiment on the large scale described by M. Breguet, the loss amounted only to thirty per cent. If during this experiment the machine which supplies the current has its motion reversed, the other machine will soon come to rest, and afterwards begin to turn in the opposite direction. The intensity of the current, M. Breguet remarks, augments with the velocity of the rotation, the electromotive force having been proved by experiment to be proportional to the velocity. At first view it might appear that the resistance would remain constant; but as the intensity is found not to be proportional to the velocity of an invariable circuit, we are led to the conclusion that the resistance of the machine is not constant. This important point has been established by M. Sabine, but the details of his experiments have not been published. The increase of resistance is, however, so small, that a machine which gives with a velocity of 100 turns per minute a current equal to that of one small Bunsen's element, will give with a double velocity a current equal to two such elements a little larger, and with a quadruple velocity a current equal to four still larger elements of Bunsen. It is certain that this increase of electromotive force cannot be indefinite, but must tend towards a limit; but this limit does not appear to have been reached even with a velocity of 3,000 turns per minute.

(*To be continued.*)

ON THE TEMPERATURE OF THE HUMAN BODY DURING MOUNTAIN-CLIMBING

IN the year 1869 both Dr. Wm. Marcet, of Nice,* and Dr. Lortet, of Lyons,† published the results of thermometric experiments prosecuted by themselves on themselves during the ascent of Mont Blanc. Both physiologists discovered that during the act of ascent, if it were rapid and prolonged for any considerable time, the temperature of the body fell considerably, as much as 3·6° F. in the case of the English, and even 8·6° F. of the French observer. The temperature was taken in the mouth, and read off by means of a small reflector attached to the thermometer, which is a much more satisfactory manner of recording reducing temperatures than the employment of maximum registering instruments. Dr. Marcet tells us that in order to assure himself that the cooling of the body during the ascent was really due to the muscular effort, and not to the effect of the rarefaction of the air, he made one ascent (from Cormayeur to the plateau of Mont-Frety, about 2,440 yards high) partly on mule-back. After having gone two-thirds the distance, his temperature was 97·5° F., when, leaving the mule, he performed the rest of the journey on foot as quickly as possible. Just before arriving at the end, his temperature was not above 95° F., or 2·5° below what it was thirty-five minutes before, at the lower level. Another peculiarity observed by this author is that the body-temperature, after having diminished during an ascending walk, rapidly rose again upon rest being taken, or on the speed being reduced.

All these unexpected results have, from the absence of fresh facts to throw light upon them, been but little discussed. It has been asked whether the above-described fall of temperature depends on the transformation of the energy of muscular action into work instead of, as usual, into heat in the body. The answer to this question is, however, not so easy as it might at first sight appear. If the exalted temperature of warm-blooded animals in a state of rest is the index of the amount of internal work done by the heart and the respiratory muscles, then extra muscular work will produce a proportionately greater rise of body-temperature, as it is employed in doing less external work, and the reverse; from which consideration it is rendered theoretically probable that the rise in temperature attending a rapid ascent of an incline would be much less considerable than that accompanying a similar effort which is attended by no external effect. In fact, the temperature of an individual in the act of throwing oranges forcibly away in all directions should be scarcely above the normal, whilst if he continually throws one up, again catching it, his temperature should rise considerably. In the one case the muscular effort is employed in heating the ground against which the moving oranges come in contact whilst being brought to rest; in the other case the energy lost to the body in the upward projection of the mass is regained in the form of heat when the muscles of the limbs resist its downward movement in catching it.

At this stage of the inquiry the elaborate investigations of Prof. Forel, of Lausanne,* prosecuted with indefatigable industry during the last four years, form an important addition to the literature of the subject. This physiologist, in a most painstaking and thorough manner, has investigated the whole problem, together with all the minor details associated with it: the results he has arrived at have consequently a wider interest than the simple solution of the question which originally led to their being commenced.

In his earlier series of experiments, Dr. Forel, whilst staying at the Rhone Glacier, at Zermatt and at the Lake of Geneva, ascended the Grimsel, the Riffel, and to Chigney, as well as to other neighbouring heights, in the end arriving at the following conclusions:—firstly, that the method of measuring the body-temperature in the mouth is not sufficiently precise for the study of the influence of muscular exercise on the general temperature of the body; and, secondly, that the act of ascending normally produced an *elevation* of the temperature of the body to the extent of several tenths of a degree, which diminishes during the subsequent repose, in tending to regain the normal standard.

These results, obtained in 1871, being directly at variance with those of Doctors Marcet and Lortet, Dr. Forel repeated his experiments with greater precision during the years 1873 and 1874. He commenced by determining the relative values of the different regions of the body in which it is possible to employ the thermometer for the estimation of the general temperature. More than a hundred observations in the floor of the mouth led him to reject that position for the thermometer, chiefly because it is next to impossible, during muscular exercise, to retain the mouth closed for any considerable time in a cold, dry, rarefied air. The palm of the hand, the arm-pit, and the external auditory meatus were rejected as being even less advantageous. The rectum was the last resource, and its advantages were found to be so great that all the most important results, to be mentioned directly, were arrived at from temperatures obtained in that situation.

The author commenced by forming a curve which represents the average temperature of his own body at the different hours of the day, in order that he might eliminate this factor as a disturbing cause in his special observations. The curve represents an elevation of the temperature between the hours of 3 and 9 A.M., and a fall between 9 P.M. and 2 A.M., with an elevated temperature during the day, the undulations of which are far from constant and are difficult to characterise. In employing these results practically, Dr. Forel has introduced a method of turning them to account, which is as useful as it is precise and ingenious. In any special experiment, calling t the temperature, and T the normal temperature at the time of observation as found from the tabulated curve, then

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* "Archives des Sciences Physiques et Naturelles." 5^e^ serie, t. xxxvi. p. 247. (Geneva.

† "Recherches Physiologiques sur le Climat des Montagnes" (Paris.)

* "Expériences sur la Température du corps Humain dans l'acte de l'ascension sur les Montagnes." (Geneva and Bale, 1871 and 1874.)

$$t - T = t'$$

t' being the difference between the observed temperature and that which, under ordinary circumstances, it would be, either above or below it. As examples, we will take two given by the author :—

At 12 o'clock, noon, $T = 99{\cdot}09°$ F. On one particular occasion t was found to be 99·5° F., and therefore

$$t - T = t' = +0{\cdot}41° \text{ F.}$$

On a second occasion, at the same time of day, the temperature observed was 98·78° F., from which it is evident that

$$t' = -0{\cdot}31.$$

By the employment of this very simple means, therefore, the complications dependent on the time of day at which an observation is made may be immediately eliminated; all comparisons being between the different values of t', and not of t. Whether the assumption that the daily curve of body-temperature-change depends on the time of the day at which the observation is made, and on the time only, is a question into which the author does not enter, notwithstanding that such is the case has been by no means proved.

Turning now to the results arrived at from the investigation, the position in which the subject was left by Marcet and Lortet may be thus summarised :—

1. The temperature of the body, as a rule, falls during the act of ascending an incline.

2. During the time of the "mountain sickness," which so frequently accompanies the ascent of lofty heights, the body-temperature falls in a very marked manner.

Dr. Forel's earlier experiments, conducted in 1871, in which the thermometer was retained in the mouth, as was done by Marcet and Lortet, being directly opposite in their tendency, led him to commence the whole subject in 1872, as he remarks *ab ovo*, under his improved conditions.

As to the effect of an uncomplicated ascent, two instances are given in full, in both of which a considerable *rise* in temperature accompanied a rapid ascent of about an hour's duration. In one of these, at the end of the journey, the thermometer registered 102·5° F., whereas it was slightly below 100° F. on starting.

In a second series, three illustrations are given of the effect of well-marked fatigue, just short of exhaustion. The following are the deductions drawn from them :—

1. Even in conditions of great fatigue, the human body rises in temperature upon the muscular effort of ascending a height.

2. It is impossible for the author to determine if the elevation of animal heat due to the movement of ascension diminishes in proportion to the increase of the muscular fatigue.

Next as to the influence of an empty stomach on the temperature curve; and it must be noted, with regard to this point, that both Marcet and Lortet have stated that the fall in temperature accompanying an ascent is more marked during a fast than shortly after a meal. On himself, Dr. Forel, however, again proves that a fast of twelve or even twenty-four hours is no obstacle whatever to the rise of temperature which attends the muscular effort of ascending a hill.

By collecting and comparing the temperature-curves produced in ascending and descending inclines, the author is enabled to verify the theoretical necessity that the body-temperature is raised more by a descent than by an ascent. From twenty-one experiments, the average rise in temperature attending the act of ascending is found to be 2·412° F., whereas the mean of seven descents is found to be 2·772° F. The difference, 0·36° F., is small, it is true. If this fact is reliable, we find that a certain amount of heat is transformed into mechanical work during the act of ascent, a certain quantity being returned to the organism from without, under the opposite condition.

There are several minor points which Dr. Forel discusses in a particularly instructive manner, amongst which are the time of cooling after muscular exertion, the effect on the pulse and respiration of mountain climbing, and the cause of mountain sickness. He terminates his very interesting observations by the account of an ascent of Mont Rosa in July 1873 (15,217 feet), in which, notwithstanding that he suffered from mountain sickness, the body-temperature never showed any tendency to fall throughout, and was 101·5° F. on his reaching the highest point.

From this summary of Dr. Forel's results, when taken in connection with those of Dr. Allbutt,* it is evident that the temperature-fall observed by Drs. Marcet and Lortet during mountain climbing requires re-verification, and cannot be accepted as a physiological fact until a fallacy has been shown to exist in the method of investigation adopted by the Swiss experimenter. A. H. G.

NOTES

AT Cairo, on the 2nd inst., the inaugural meeting took place of the Société Khédivale de Geographie, under the presidency of the eminent traveller Dr. Schweinfurth and the patronage of H.H. the Khedive, who has shown special favour to the young society, having placed at its disposal a handsome suite of apartments furnished in suitable style, and also presented a valuable library, besides subscribing 400*l.* a year to the funds. This cannot but be gratifying to the friends of science and progress, and is a hopeful sign for the future of Egypt and of the extensive region from which it claims allegiance. Let us hope that like results will follow the intercourse between this country and the Sovereign of Zanzibar. With these two African potentates on the side of progress, the advantages to knowledge, as well as to Africa, could not but be great. At all events, under the powerful patronage of the Khedive, this Egyptian Geographical Society is bound to make valuable contributions to our knowledge of North Africa. Dr. Schweinfurth, in his inaugural address, which was characterised by great fervour, spoke of the domain and progress of geography. "It has become," he said, "an immense domain, the meeting-place of all branches of human science. The geography of the present does not aim at merely describing the external form of the earth, the vesture which it has assumed; it seeks to show the chain of hidden causes of which this form is the expression." He then spoke of Africa and the great interest attaching to it, and especially to the Nile, the sources of which he believes contain the key to all the mysteries of Africa. Dr. Schweinfurth then referred to the history of Egypt and its progress under its present ruler, by whose special desire the Society has been organised. The motto of the Society, he said, should be *Nusquam otiosus*, and its duty *Centraliser et encourager*. After pointing out to those who take a "utilitarian" view of science, that all the comforts and commodities of modern life are due to researches which, though purely theoretical in their origin, have yielded magnificent practical results, Dr. Schweinfurth indicated the benefits to be gained from the increase of geographical knowledge, and described the organisation of the new Society and the task which lies before it. He showed what advantages a Society so situated had over European societies for extending our knowledge of Africa, and pointed out what yet remained to be done ere the topography of North Africa could be considered anything like completely known. We notice that the principal geographical societies of Europe and America have sent their congratulations to Dr. Schweinfurth on the founding of this Society; England's name, however, is not mentioned.

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* *Journal of Anatomy and Physiology*, vol. xi. p. 106.

MR. MACLEAY, who has organised the expedition to New Guinea, our readers may remember, has already liberally endowed Sydney University. The ship he has fitted out for exploring New Guinea is a 400-ton man-of-war. His chief object is to enrich his Natural History collection, and he intends to do deep-sea dredging; he takes also a steam launch for ascending the rivers. There is one immense river, named the "Fly" River, after H.M.S. *Fly*, about which nothing is known. Mr. Macleay thinks that he will be able to ascend some 200 miles.

M. POLJAKOW, commissioned by the Russian Geographical Society, undertook a journey last year into the region of the Upper Volga, chiefly for zoological purposes, though he also obtained some important geologico-geographical results, an account of which appears in Heft vi. of Petermann's *Mittheilungen*. From the observations which he made, Poljakow concludes that the Scandinavian Finlandic glacier which once held in its fetters the government of Olonez and the neighbouring governments, must have stretched far into the basin of the Volga and over the boundaries of the Waldai plateau; and that by the unequal levels of the lakes formed by the melting of the glacier, the slender remains of which are seen in the existing lakes, undoubtedly a connection existed between the basin of the Volga and the Arctic and Baltic seas. Judging from the fauna, Poljakow concludes that the present upper course of the Volga must have been joined to the middle and lower course at a recent period and in a manner accidentally. The upper river has an entirely different and indeed a more northern water fauna than the middle and lower river. In this respect is the Scheksna to be considered the natural upper part of the Volga, for it contains the very same fishes as that river as far as Bjelosero.

DR. FOREL, of Lausanne, has for several years been investigating what are known as the *Seiches* of the Lake of Geneva. *Seiche* is applied locally to certain oscillatory movements which are occasionally seen to occur on the surface of the lake. The phenomenon had been investigated by previous observers, among others by Saussure and Vaucher, who attributed the phenomenon to variations in atmospheric pressure; in this, Forel, who has most minutely investigated the phenomenon, agrees with them. The phenomenon is found to occur on other Swiss lakes, and Forel believes it will be found in all large bodies of water. Indeed, he recognises in the *Seiche* probably the most considerable and the grandest oscillatory movement which can be studied on the surface of the globe. His investigations have led him to the conclusion that the *Seiche* on the Swiss lakes is an oscillatory undulation (*ondulation de balancement*), having a true rhythm, and that the phenomenon is not occasional, but constant, though varying in degree. The duration of a *Seiche* is a function of the length and depth of the section of the lake along which it oscillates; this duration increases directly with the length and inversely with the depth of the lake. The instrument he has devised for the investigation of the phenomenon he calls a *plémyramètre* ("tide-measurer"). A detailed account of Forel's investigations will be found in two papers in the *Bull. de la Soc. vaud. des Sciences Naturelles*, tomes xii. and xiii. Both papers have been republished separately.

HEFT VI. of Petermann's *Mittheilungen* contains a valuable paper by Vice-Admiral B. v. Wüllerstorf-Urbair on the Meteorological Observations made by the recent Austro-Hungarian Arctic Expedition, with an analysis of the ship's course. The paper is accompanied by a chart showing the drift of the ice, the course of the ship, the depths of soundings, the direction of the wind, and various other data.

AT the meeting of the Geographical Society on Monday, a lecture was delivered by Admiral Sir Leopold M'Clintock on "Arctic Sledge Travelling." After an account of the expeditions of former Arctic travellers, from Parry downwards, Sir Leopold gave a description of the appliances required for Arctic travelling, and of the difficulties to be encountered. To sledging, he said, we are indebted for almost all our Arctic experiences, and to sledging we shall owe the principal share of whatever work may be done by the brave men now going out. The greatest bar to their progress would be ice too thin to sledge over; sledge-bearing ice or open water their equipments will enable them to traverse.

AN opportunity will occur of sending letters for the Arctic ships *Alert* and *Discovery* by the exploring yacht *Pandora*, which will leave Portsmouth about the 23rd instant, Mr. Allen Young, commanding that vessel, having consented to receive letters, newspapers, &c., upon the chance of their being delivered to or deposited for those ships. No articles of value should be sent, and letters, &c., should be addressed to the General Post Office, and marked "Per exploring yacht *Pandora*."

A VERY full and interesting *résumé* of the progress of geographical discovery and of the sciences connected with geography, by M. Charles Maunoir, appears in the April number, just issued, of the *Bulletin* of the French Geographical Society; it is illustrated by a series of small maps. The same number contains the plan of a scientific journey into the interior of Indo-China, by Dr. J. Harmand.

NEW YORK telegrams of June 12 report a terrible earthquake in the Cucuta Valley, Republic of New Grenada. Cucuta, it is stated, has been entirely destroyed. Five other towns were nearly destroyed, and 16,000 persons are reported lost, out of a population of 35,000.

A TELEGRAM dated Barcelona, June 10, states that some shocks of earthquake had been felt there and in the neighbouring villages.

THE U.S. Hydrographic Office, of which Commodore R. H. Wyman, U.S.N., is superintendent, has commenced the systematic establishment of secondary meridians by telegraphic exchange of time-signals. Lieut.-Commander F. M. Green, U.S.N., is at present in charge of the work, and has during the past winter made observations at Panama, Colon, Kingston, Santiago di Cuba, and Havana. The starting-point used for the determination of longitude has been the meridian of Key West, Florida, established with great care by the U.S. Coast Survey. In addition to longitude observations, the latitude of each station has been determined with the zenith telescope. The work will be continued next winter through the Windward Islands to Guiana and Brazil. The liberal conduct of the companies owning the cables has much facilitated the successful prosecution of the work.

WE may see from the following extract from the New York *Nation* how very closely our doings on this side of the water are watched. The appointments referred to we have already announced in NATURE, but the comments upon them by the *Nation* indicate what we hope will be the method pursued by England in the course of time, though we fear the course will be a very long one. "Two recent appointments," the *Nation* says, "in the University of Zürich seem to merit notice, as signs of the times. One is that of Prof. W. Wundt to the Chair of Philosophy, the other that of Prof. E. Hitzig to the Chair of Psychology. Wundt has long been occupied at Heidelberg, first as Assistant, then as 'Ordinary' Professor of Physiology, whilst Hitzig has been a medical practitioner and lecturer on electro-therapeutics in Berlin. So far as we know, the latter has written nothing on purely mental science. His discovery of the irritability of the surface of the brain is his chief title to fame; all that he has written shows erudition, great experimental thoroughness, and conscientiousness in drawing inferences. Wundt is one of the most learned of German investigators. His own special work has lain most in the line of the senses and the nervous system, the territory common to mind and matter; and all the elements of his training hitherto unite to make him an eminently well-qualified teacher of mental science. Indeed, we doubt not that his long apprenticeship in physiology was accepted by him merely that he might be the better educated for philosophy. In this country such appointments would probably provoke a good deal of orthodox alarm. But in Germany not only is thought more fearless of consequences, but 'camps' in opinion are much less clearly defined, and materialistic and spiritualistic tendencies keep house together most amicably in the same professional brains. We cannot help regarding such appointments as these as hopeful tokens of a new era in philosophical studies—an era in which the old jealousy between the subjective and the objective methods shall have disappeared, and in which it shall be admitted that the only hope of reaching *general* truths that all may accept is through the co-operation of all in the minute investigation of special mental processes. We may then see solid philosophical conclusions gradually emerging from the mass of discoveries of detail, just as happens in the sciences more especially recognised as 'inductive.'"

WE take the following from the *Athenæum*:—Mr. William Davis, who has been an attendant at the British Museum since 1843, but has practically fulfilled, for a long time past, duties requiring considerable scientific acquirements for a salary which, after the lapse of thirty years, had risen to the magnificent sum of some twenty-five shillings a week, was on Wednesday appointed by the Trustees an assistant in the Department of Geology. Mr. Davis was the first recipient of the Murchison Medal of the Geological Society, and is a well-known authority upon vertebrate fossils, especially fishes and mammalia.

THE series of papers on Portuguese Travel by Mr. John Latouche, which have appeared in the *New Quarterly Magazine*, are shortly to be published by Messrs. Ward, Lock, and Tyler, under the title of "Travels in Portugal," with illustrations by the Right Hon. T. Sotheron-Estcourt.

A TELEGRAM, dated "Strangway Springs, April 17," has been received from Mr. Ernest Giles, who has been exploring to the north of Fowler's Bay, Australia. He had had one long stretch of 220 miles without water; all the horses died, and he was only saved by his two camels. Mr. Lewis's expedition to Lake Hope, South Australia, has proved successful. Lake Hope he found perfectly dry. Before completing his work, Mr. Lewis purposes endeavouring to discover a route between the south-west portion of Queensland and the north-west of New South Wales, with a view of establishing direct overland communication with the former colony.

THE annual meeting of the Palestine Exploration Fund was held last Thursday. Since the Society was founded in 1865, four expeditions have been made, and surveys and excavations effected. The surveys have extended from Mount Carmel in the north to Beersheba in the south, and from Askelon in the west to the Dead Sea.

THE death of the lamented Rémusat has created a majority in favour of M. Dumas in the election which will take place at the Académie Française five months hence. It was owing to the prospect of a vacancy that the election was postponed when the Academicians were unable to agree after three successive meetings.

THE death is announced, on June 9, at the age of seventy-nine years, of M. Deshayes, Professor in the Paris Musum of Natural History.

La Revue Scientifique records the death, on May 11, at the age of thirty-two years, at Algiers, of a distinguished Mussulman chemist, Abdallah ben Mohammed. His mission was to instruct in the physical sciences, and especially in chemistry, the native Algerians; for this purpose he had to devise an Arabic terminology.

THE death is announced of Senhor Joaquim Henriques Fradesso da Silveira, director of the Meteorological Observatory of the Infanta Don Louis at Lisbon.

THE Professorship of Chemistry at Munich, we learn from the *British Medical Journal*, which has remained vacant since the death of Liebig, has been accepted by Prof. Baeyer of Strasburg, who will commence his duties next winter session.

THE jury of the Exhibition of the French Central Society of Horticulture has awarded a large gold medal to M. De la Bastie for his discovery of hardened glass, on account of the services it is likely to render to horticulture.

THE Annual Report of the United States Geological and Geographical Survey, describing the explorations of the year 1873, which has just reached us, contains, besides the descriptive letter-press, several valuable illustrations of some of the more recently discovered genera and species of Mammalia belonging to genera closely allied to Dinoceras (Marsh). These include *Symborodon bucco* (Cope), *S. Saltirostris*, and *S. ater*, all very peculiar forms.

WE have received the third Annual Report of the Zoological Society of Philadelphia, just published, which tells very strongly in favour of the institution. The additions by presentation and purchase are numerous, including six Giraffes, an Elk, an African and an Indian Elephant, and a Ka-Ka Parrot. We may judge that the Gardens are constantly kept in view by the citizens in their travels, from the fact that not less than twenty-three alligators were presented within three months.

THE President of the Italian Geographical Society has received favourable intelligence of the expedition sent to examine the possibility of conducting the waters of the sea into the hollow basins of the Sahara. The expedition will be divided into two parties at Gares. One is to explore the Oasis of Gerid, and carry out some interesting collateral researches among the ruins of Carthage, particularly the remains of the aqueducts and the remarkable lead mountain of Gebel Drucas.

AN attempt which has just been made to introduce living humming-birds into the Paris Jardin d'Acclimatation has failed, although a traveller managed to bring six alive to Paris by feeding them with honey. The only other humming-birds which have reached Europe alive were those brought by M. Delattre in 1855 from Central America, but these died a fortnight after their arrival in Paris.

"NURAGGHI SARDI, and other Non-historic Stone Structures of the Mediterranean Basin," is the title of an illustrated pamphlet by Capt. S. P. Oliver, who offers it "as a slight contribution towards the constantly increasing knowledge of those pre-historic remains which are scattered in mysterious groups throughout the Old World." Carson Brothers, of Dublin, are the publishers.

THE additions to the Zoological Society's Gardens during the past week include a Grant's Gazelle (*Gazella granti*) from East Africa, presented by Dr. Kirk; a Beccari's Cassowary (*Casuarius beccarii*) from New Guinea, presented by Sir James Fergusson; an Owen's Apteryx (*Apteryx oweni*), two Weka Rails (*Ocydromus australis*), a Black Wood Hen (*Ocydromus fuscus*), from New Zealand, presented by Dr. G. Hector; two Australian Cranes (*Grus australasiana*) from Australia, presented by the Acclimatisation Society of Wellington, New Zealand; a Brown Indian Antelope (*Tetraceros subquadricornutus*) from India, a Dufresne's Amazon (*Chrysotis dufresniana*) from South-east Brazil, four Vulturine Guinea Fowls (*Numida vulturina*) from East Africa, an Anaconda (*Eunectes murinus*) from South America, purchased.

RECENT PROGRESS IN OUR KNOWLEDGE OF THE CILIATE INFUSORIA[*]

I BELIEVE that the object contemplated by the addresses which it has been the custom of your Presidents to deliver year after year to the Fellows of the Linnean Society will be best fulfilled by making them as much as possible the exponent of recent progress in biological science. The admirable addresses with which my distinguished predecessor has during his long tenure of office so greatly enriched our journal, afford an example as regards the exposition of botanical research which may well be followed in biology generally. The field, however, which thus offers itself is so wide, the activity in almost every department so intense, that the necessity of restricting the exposition within a limited area becomes imperative if it be expected to produce anything like a definite picture instead of a vast assemblage of images confused and ill-defined by their very multiplicity and by the condensation which would be inseparable from their treatment.

While thus imposing on myself these necessary limits, it is almost at random that I have chosen for this year's address some account of the progress which has recently been made in our knowledge of the CILIATE INFUSORIA—a group of organisms whose very low position in the animal kingdom in no way lessens their interest for the philosophic biologist, or their significance in relation to general morphological laws.

To enable you to form a correct estimate of the value of recent researches, it may be well to bring before you in the first place, as shortly as possible, the chief steps which have led up to the present stand-point of our knowledge of these organisms.

It is scarcely necessary to remind you that the first important advance which during the present century was made in our knowledge of the Infusoria dates from the publication of the great work of Ehrenberg,[*] whose unrivalled industry opened up a new field of research when, by his expressive figures and well-constructed diagnoses, he made us acquainted with the external forms of whole hosts of microscopic organisms of which we had been hitherto entirely ignorant, or which were known only by such figures and descriptions as the earlier observers with their very imperfect microscopes were able to give us.

Ehrenberg, however, as we all know, did not content himself with pourtraying the external forms of the microscopic organisms to whose study he had devoted himself, but sought also to determine their internal structure, of which scarcely anything had been hitherto known. In this direction, no less than in the other, the perseverance of the celebrated microscopist never flagged; but, unfortunately, at the very commencement of his researches he slid into a misleading path, and was never again able to find the right one.

Everyone knows how Ehrenberg, in accordance with preconceived notions of the high organisation of *all* animals, attributed to the Infusoria a complicated structure; how, while he rightly distinguished them from the Rotiferæ with which they had been confounded by previous observers, he yet regarded them as intimately related to these representatives of a totally different type; and how, in attributing to them a complete alimentary canal with numerous gastric offsets, he took this feature as their most important character, and designated them by the name of *Polygastrica*. And it is probably a matter of surprise to many of us, that with the overwhelming mass of evidence which subsequent research has brought to bear against the truth of the polygastric theory, the great Prussian observer should still adhere with undiminished tenacity to his original views.

Among the authors who, since the publication of the "Infusionsthierchen" have contributed most to a correct estimate of the morphology, physiology, and systematic position of the Infusoria, the names of Von Siebold, Stein, Balbiani, Claparede, and Lachmann, and most recently, Haeckel, stand out conspicuous.

The first who from a strong position offered battle to the authority of Ehrenberg was Carl Theodor von Siebold.[*] Von Siebold rejected *in toto* the polygastric theory, and, so far from admitting a complexity in the organisation of the Infusoria, he regarded them as realising the conception of almost the very simplest form of life, and attributed to them the morphological value of a cell.

Let us see what is involved in this most significant comparison. The essential conception of a cell is, as you know, that of a more or less spherical mass of protoplasm with or without an external bounding membrane, and with an internal nucleus or differentiated and more or less condensed portion of the protoplasm. It was to a form of this kind that Siebold compared the body of an Infusorium. He called attention to the soft protoplasmic mass of which the body mainly consists; to the external firmer layer by which this is surrounded; and to the variously-shaped body differentiated in the protoplasm, to which Ehrenberg had gratuitously attributed the function of a male generative organ. Here then were, according to Siebold, the protoplasm body substance, the bounding membrane, and the nucleus of a true cell.

The morphological value thus attributed to the true Infusoria—under which were included the Flagellatæ—was extended by Siebold to Amœba and its allies, and to the whole assemblage so constituted he assigned the position of a primary group of the animal kingdom to which he gave the name of PROTOZOA, whose essential character was thus that of being unicellular animals. He then divided his Protozoa into those which had the faculty of emitting pseudopodial prolongations of their protoplasm (Amœba, &c.), and those in which the place of the pseudopodia was taken by vibratile cilia or by lash-like appendages. To the former he gave the name of *Rhizopoda*; to the latter he restricted that of *Infusoria*; and lastly he divided the Infusoria into the mouth-bearing, *Stomatoda* (Ciliata), and the mouthless, *Astomata* (Flagellata). From every point of view Von Siebold's conception of the morphology of the Protozoa, and his sketch of their classification, however much this may have been subsequently modified, must be regarded as marking out an epoch in the history of zoology.

Shortly after this the unicellular theory was strongly supported by Kölliker,[†] and received further confirmation from the researches of Stein,[‡] who, however, was unable to accept it to its full extent. With an industry almost equal to that of Ehrenberg, Stein had the advantage of the more philosophic views of organisation which had emanated from the newer schools of biology, and to him we are indebted not only for more accurate views of the structure of the Infusoria, but for the first important contributions to our knowledge of their development; and though the opinion which he at one time entertained, that the true Acinetæ are only stages in the development of the higher Infusoria, has been abandoned by him, he has nevertheless demonstrated the presence in an early period of the development of certain species, of peculiar pseudopodial processes resembling the characteristic capitate appendages of the Acinetæ, an observation of importance in its bearing on the relations of these last to the true Infusoria. No doubt can remain, after Stein's observations, that the Infusoria in their young state have the morphological value of a simple cell, and it is only after their development has become advanced, and that a marked differentiation has begun to manifest itself in this primordial condition, that there can be any difficulty in accepting their absolute unicellularity.

About this time Balbiani drew attention to some very important phenomena in the life history of the Infusoria.[§] It had been known even to the early observers that the Infusoria multiplied themselves by a process of spontaneous fission. They had been frequently observed in the act of transverse cleavage, and had also been noticed in what appeared to be a similar cleavage taking place in a longitudinal instead of a transverse direction. Balbiani, however, showed that this apparent longitudinal cleavage had in many cases an entirely different significance; that it was, in fact, not the cleavage of a single individual, but the conjugation of two distinct ones; and he connected this phenomenon with what he regarded as a true sexual act.

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[*] Anniversary Address to the Linnean Society, by the President, Dr. G. J. Allman, F.R.S., May 24.

[†] "Die Infusionsthierchen als vollkommene Organismen." Leipzig, 1838.

[*] Siebold, "Lehrbuch der vergleichenden Anatomie," 1845.

[†] Zeitschr. f. Wissens. Zool, 1849.

[‡] Stein, "Der Organismus der Infusionsthiere," 1867.

[§] Balbiani, "Recherches sur les organes générateurs et la réproduction des Infusoires." *Comptes Rendus*, 1858, p. 383.

It was then known that besides the nucleus which occupied a conspicuous position in the protoplasmic mass, there existed in many Infusoria another differentiated body similar to the nucleus but smaller, and either in close contact with it or separated from it by a greater or less interval. To this body the ill-chosen name of "nucleolus" had been given. Now, Balbiani's observations led him to believe that under the influence of conjugation this so-called nucleolus underwent a change and developed in its interior a multitude of exceedingly minute filaments or rod-like bodies, to which he attributed the significance of spermatozoa; while at the same time the nucleus became divided into globular masses, which Balbiani regarded as eggs, and in which he believed he could recognise a germinal vesicle and germinal spot. We should thus, according to this interpretation, have in the Infusoria the two essential elements of sexual differentiation, the spermatozoa and the egg.

Stein, though differing from Balbiani in certain details, accepts in its general facts the sexual theory, and maintains the spermatic nature of the rod-like corpuscles to which the nucleolus appears to give rise. But however real may be the phenomena described by Balbiani and by Stein, the correctness of assigning to them a sexual significance may be called in question; and it is certain that subsequent observation has not tended to confirm the hypothesis that we have in the Infusoria true eggs fecundated by true spermatozoa.

Claparede and Lachmann, two able and indefatigable observers fresh from the school of the great anatomist Johan Müller, now entered the field, and their joint labours have given us a great work on the Infusoria.[*] In this an entirely new view of the morphology of the Infusoria has been introduced. Receding widely from the unicellular theory of Siebold, they approximate towards the views of Ehrenberg in assigning to the Infusoria a comparatively complex structure; but instead of adopting the polygastric theory of the Prussian microscopist, they attribute to the Infusoria a single well-defined gastric cavity occupying the whole of the space limited externally by the outer firm boundary walls of the softer protoplasmic mass; while this mass is regarded by them as nothing more than a sort of chyme by which the gastric cavity is filled. According to this view, the nearest relations of the Infusoria would be found among the zoophytes, and their proper systematic seat would be in the primary group of the Cœlenterata.

Though few zoologists will now be prepared to accept the conclusions of the Genevan naturalists, the cœlenterate relations of the Infusoria has recently found an advocate in Greeff.[†] In an elaborate memoir on the Vorticellæ, Greeff sees in the very well-marked distinction between the external or cortical layer and the internal soft body-substance, a proof of the views maintained by Claparede and Lachmann; and he considers this position still further confirmed by the presence in *Epistylis flavicans* of numerous oval or piriform, brilliant, well-defined capsules, which are generally distributed in pairs below the outer layer, and which, under the influence of a stimulus, emit a long filament, thus closely resembling the thread-cells so well known as characteristic elements in certain tissues of the Cœlenterata.

It must be here remarked that the presence of similar bodies in the Infusoria, where they have been described under the name of trichocysts, has long been known. Though varying in form, they all possess a more or less close resemblance to the thread-cells of the Cœlenterata. Their presence undoubtedly indicates a step upwards in the differentiation of the organism, but, as we shall presently see, it offers no valid argument against its unicellularity.

In his admirable "Principles of Comparative Anatomy,"[‡] Gegenbaur expresses doubts as to the sexual nature of the reproductive phenomena of the Infusoria, and is disposed to regard the so-called embryo-sphere, to which the nucleus gives rise, in the light of a proliferous stolon, from which several zooids are in some cases thrown off. Arguing from the Acineta-like form of the young in the higher Infusoria, as shown by Stein, and comparing the transitory condition of this with the permanent condition of the true Acinetæ, he believes that we are justified in regarding the Acinetæ as the ancestral form from which the proper Infusoria have been derived. He further compares the contractile vesicle and its canals in the Infusoria with the water vascular system of the worms, and believes that a parentage with these higher forms is thus indicated. Gegenbaur, moreover, expresses himself strongly against the unicellular theory. He regards, however, the absence of distinct cell nuclei in the substance of the Infusoria as affording evidence of their composition out of several "Cytodes" or non-nucleated protoplasm masses rather than out of true nucleated cells.

Still more recently Bütschli has given us the results of observations on the conjugation of *Paramæcium aurelia.*[*] He is led, however, to doubt the validity of the sexual interpretation of the conjugation. He found that in certain cases in *Paramæcium aurelia* and in *P. colpoda* the so-called spermatic capsule into which the nucleolus had become converted, had entirely disappeared without any evident change in the nucleus; and he concludes that fecundation of the bodies regarded by Balbiani as eggs cannot be here entertained. Indeed, he will not allow that we have evidence entitling us to regard the appearance of filaments in the interior of the nucleolus as affording any indication of true spermatozoa. He offers no explanation of this appearance, but he calls attention to the fact that both Balbiani and Stein noticed that in *transverse* division of the Infusoria—a phenomenon with which conjugation can have nothing to do—the nucleolus frequently enlarges and acquires a longitudinal striation like that of the nucleolus in the supposed production of spermatozoa during conjugation. Balbiani maintains that this striation during cleavage is only superficial, but it nevertheless affords an argument against assigning any more important significance to the very similar appearance in the case of conjugation.

On the whole it would appear that the spermatozoal nature of the striæ visible in the nucleolus of the conjugating individuals—even admitting that these striæ represent isolatable filaments—has not by any means been proved, while the phenomenon of conjugation in the Infusoria would seem to correspond rather with the conjugation so well known in many lower organisms, where it takes place without being in any way connected with the formation of true sexual products.

In the same memoir the results of observations on some other points in the structure and economy of the Infusoria have also been given by Bütschli. He records the occurrence of minute crystal-like laminæ in the interior of a marine Infusorium (*Strombidium sulcatum*) rendered remarkable by a conspicuous girdle of trichocysts which surround its body. The crystal-like corpuscles seem to be of the nature of starch, for on the application of iodine they assume a beautiful violet colour. It does not appear from Bütschli's account of these bodies that they have not been introduced from without, and the chief interest of the observation seems to be in the discovery of an amyllaceous body assuming a crystalline form. He had previously met with similar bodies in a parasitic Infusorium (*Nyctotherus ovalis*), as well as in a Gregarina (*G. blattarum*).

He also describes, under the name of *Polykricos Swartzii*, a new Infusorium which he frequently found in the fjords of the south coast of Norway and in the Gulf of Kiel, and which he regards as especially interesting, from the fact that with a true infusorial organisation it contains, irregularly distributed in the outer layer of the body, numerous capsules indistinguishable from the true cœlenterate thread cells. These bodies, however, are never included in a special investment, and he justly regards their presence as affording no argument against the unicellular nature of the Infusoria. He lays it down as a probable distinction between the trichocysts of the Infusoria and genuine thread-cells, that the former have the power of ejecting their contained filament from both ends of the capsule, while we know that in the thread cell it is only one end which gives exit to it. This double emission of a filament appears to have been observed by Bütschli in the trichocysts of a large Nassula, but the distinction is certainly not a generally valid one. There is no doubt that in the majority of cases the trichocyst emits its filament from only one end of its capsule, exactly as in the thread cells of the Cœlenterata, and it is hard to see in what respect the bodies noticed by Bütschli in his *Polykricos Swartzii* essentially differ from true infusorial trichocysts. In conlusion, he declares himself strongly in favour of the unicellularity of the Infusoria.

(*To be continued.*)

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[*] Claparede et Lachmann, "Etudes sur les Infusoires et les Rhizopodes." Genève, 1858–61.

[†] Greeff, "Untersuchungen über den Ban und die Naturgeschichte der Vorticellen." Archiv für Naturg., 1870.

[‡] "Grundsüge der Vergleichenden Anatomie," 1870.

[*] O. Bütschli, "Einiges über Infusorien." Archiv f. Microscop. Anat., 1873.

SCIENTIFIC SERIALS

THE current number of the *Journal of Anatomy and Physiology* contains much valuable scientific work, together with its excellent Reports on the progress of Anatomy and Physiology, by Prof. Turner and Dr. Stirling. The first paper is one on the freezing process for section-cutting, and on various methods of staining and mounting sections, by Mr. Lawson Tait. The author prefers the non-employment of chromic acid, picric acid, and other chemically-interfering agents. His section-cutter is a modification of Stirling's, a freezing tank of considerable size being added. The air-bubbles are removed from the sections by the action of boiled water. Logwood and litmus are preferred as staining agents, and their operation is given in proof of the nuclei of cells being, contrary to ordinary ideas, alkaline.—Prof. Flower, in a note on the construction and and arrangement of anatomical museums, makes several very valuable suggestions, which should be specially studied by those who have anything to do with the establishment and construction of biological museums. He shows how that in lofty rooms, with galleries, lighted at the ceiling-wall junction, the preparations have to be arranged according to their manner of preservation; dry, in bottles, and otherwise; which involves the separation of those illustrating any single subject. A series of small side-lighted rooms allows of all the specimens illustrating any single subject, however preserved, being placed in juxtaposition, whilst it separates off the subjects.—Dr. Hollis remarks, with several interesting historical references, on lopsided generation.—The next paper is by Mr. Walter Pye, entitled observations on the development and structure of the kidney. The relation of the capsule to the Malpighian tuft is explained upon the peculiarities observed in the developing organ in a manner differing from the results of Riedel. The characters of the ascending limbs of Henle's loops are described in detail. A plate accompanies the paper.—Mr. Lowne, in a note on the mechanical work of respiration, desires to prove that the amount of work performed in the respiratory act is much less than is usually stated, from calculations based on the relation between the velocity of moving gases and the pressure producing motion.—Dr. Howden describes a case of atrophy of the right hemisphere of the cerebrum attended with the same condition of the left side of the cerebellum and the left side of the body, in a woman aged 30.—Prof. Turner figures and describes the Spiny Shark (*Echinorhinus spinosus*) from a specimen captured near Bass Rock, six-and-a-half feet long. The ureters were found to open into the cloaca by a single orifice. There was no cement gland in the oviduct, from which it is evident that the ova have no horny case. The stomach is succeeded by a pyloric tube; pyloric cæca are absent. In comparing *Læmargus* and *Echinorhinus*, which are supposed to be closely related, it is found that the former possesses two large duodenal cæca and no oviducts, whilst in the latter cæca are absent and oviducts developed. Prof. Turner also proves, from a specimen caught off the mouth of the Frith of Forth, that the Postbeagle Shark (*Lamna cornubica*) possesses a spiracle, contrary to the opinion of most authorities.—Mr. D. J. Cunningham gives notes on the Great Splanchnic Ganglion. In twenty-six cases, he failed to detect its presence in six; it is situated on the body of the twelfth dorsal vertebra; it is variable in shape and size. The same author describes a case of lateral curvature of the spine in connection with hypertrophy of the sympathetic nervous system in the lumbar and sacral regions.—Mr. Dwight makes remarks on the position of the femur and on its so-called "true neck."—Drs. Kronecker and Stirling describe in detail experiments on the characteristic sign of cardiac muscular movement. The fundamental fact on which the investigation is based is the law of Bowditch, that "the induction current of the weakest strength which produces a contraction of the heart does not produce the weakest of possible contractions." The fact that after a pulsation has been developed in the heart of a frog, by a certain stimulation, the organ can be made to continue its beating with a diminished stimulus, is compared to the difference between the effort first required to sound a big bell and that necessary to maintain it ringing. The effect of temperature on the cardiac irritability is shown, the heart reaching its maximum mobility at 25° C. After the discussion of the difficult phenomenon of cardiac tetanus, the authors prove that "the cardiac muscles can only act equally with the help of continually new nutrient fluid." The paper is deserving of the attention of all physiologists.—Dr. Kronecker also describes a new digestion-oven with a diffusion apparatus.—Mr. J. C. Ewart has a note on a large organised cyst in the subdural space.—Mr. J. Reoch writes on the decomposition of urea, adducing evidence to show that in urine the urea is changed into carbonate of ammonia by the action of a fungus the germs of which are contained in the atmosphere.—Mr. M. Simpson describes the existence of two precaval veins in a dog, a condition constant in the kangaroo and some other animals.

Report of the Rugby School Natural History Society for the Year 1874.—We are glad to be able to say that this Report is a satisfactory one; all the sections have done a fair quantity of good work, and a large proportion of the papers read has been the work of actual members or associates. The papers are all highly creditable to the authors, and many of them give evidence of well-trained powers of observation. Mr. J. M. Wilson contributes three interesting papers. One, "On the construction of a geological model of the neighbourhood of Rugby," contains some queries and suggestions as to how such a work should be gone about, and we are glad to see that the model has actually been commenced and has already made considerable progress. This is really most profitable work on which to employ the members of the Society. Other papers by Mr. Wilson are, "On the companion of Sirius," a note of an observation on the *comes* of Sirius, from which Mr. Wilson infers that it has performed twenty-three degrees of its revolution in ten years; and "On the Geology of Hillmorton." The following titles of papers by members will give an idea of the work done by the Society:—"On Mounting for the Microscope," by E. J. Power; "On the Will-o'-the-Wisp," by H. W. Trott; "On Owls," by H. Vicars; "On the Sub-Wealden Explorations," by R. D. Oldham; "On an Entomological Expedition," by H. F. Wilson, who also contributes a paper "On the Great Spotted Woodpecker;" "On Migrations," by W. C. Marshall; "On Bees," by H. Vicars; "On Roman Remains near Church Lawford," by L. Knowles; "On Drops of Liquid," by H. F. Newall, a very interesting paper, giving evidence of some faculty for original research; "On Cuckoos," by W. Larden. Mr. Newall's paper on drops is illustrated by some carefully executed drawings. The same member has constructed an ingenious compound pendulum machine, an illustration of which is given, as also illustrations of some most delicate curves executed by the machine. Among other illustrations we may mention a heliotype copy of a drawing by J. H. Patry of fifteen various observations of the planet Mars, taken at the Temple Observatory. Very full sectional reports are appended, and under the head of "Statistics" a variety of information is given. Altogether this is one of the most satisfactory reports published by this Society.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, April 15.—This number contains an article by Prof. Buys-Ballot on the climate of Buenos Ayres, and another on the hailstones which have occurred in Würtemberg during the forty-six years 1828–73.

Bulletin de l'Académie Royale des Sciences de Belgique, 2 ser. t. xxxix. No. 3.—This number contains a note on *Pecopteris odontopteroides* (Morris), by M. François Crépin. There is a fossil from the coal measures of Hobart Town among those sent by Mr. Allport to the museum, which M. Crépin refers to the same species as that named by Prof. Morris. He doubts, however, whether Prof. Morris has assigned his specimen to its true relationships, believes it is nearer to *Odontopteris alpina* (Gein), and provisionally proposes *Odontopteris Morisii* as its name.—On the *calcaire carbonifère* between Tournai and the environs of Namur, by M. E. Dupont; a description of forty-seven pages, with two coloured folding plates of sections.—Researches on the structure of the corda dorsalis of Amphioxus, by M. Camille Moreau. The work was carried on in the microscopical laboratory of the University of Liége, under the direction of Prof. E. Van Beneden. The paper consists of a description with a plate. To complete the working out of the homologues of the layers, further embryological observations, M. Moreau says, are necessary.—No. 4. The communications in this number are:—Note on the temperature of the winter of 1874–75, by M. Quetelet. The winter is compared with that of 1859–60, and a table showing the resemblance is given.—Note on the halo with mock moons of March 23, 1875, by M. Chas. Hooreman.—On the theory of the use of hot air in furnaces, by M. H. Valérius.—On some fossil plants from the "Psammites du Condroz," by M. A. Gilkinet. This paper is partly of criticism on the work of M. Crépin, and is partly descriptive. Three folding plates of illustrations are given.

Archives des Sciences Physiques et Naturelles, vol. 52, No. 207 (March 15, 1875).—This part contains many papers translated and reprinted from other serials, besides several original ones. We note the following:—On the fossil vertebrata of the State of Nebraska, by M. Delafontaine. On the measurement of altitudes in Switzerland, executed by MM. Hirsch and Plantamour. On the action of galvanic currents upon alloys or amalgama, by M. Eugène Obach. On some experiments with Holtz's machine, by F. Rossetti. Researches on the spectrum of chlorophyll, by J. Chautard.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, June 3.—Dr. G. J. Allman, F.R.S., president, in the chair.—The President nominated the following gentlemen as Vice-presidents for the ensuing year, viz.:—Mr. G. Bentham, F.R.S.; Mr. G. Busk, F.R.S.; Dr. J. G. Jeffreys, F.R.S.; and Dr. J. D. Hooker, P.R.S.—Prof. Thiselton Dyer exhibited, under the microscope, some specimens of the very rare Alga *Stephanosphæra pluvialis*, known to occur only in a single locality in Britain, a pool on Bray Head, in Ireland.—Dr. Trimen exhibited specimens of two recent additions to the British flora, *Zannichellia polycarpa*, found by Dr. Boswell-Syme in the Orkney Islands in 1847, and *Carex ornithopoda*, discovered by two working men in Derbyshire.—Mr. Pascoe exhibited a very fine collection of Crustacea from the Bay of Naples. The following papers were then read:—On the Barringtoniaceæ, by J. Miers, F.R.S. The purpose of this paper is to show that the Barringtoniaceæ constitute a distinct order, forming an extremely natural group with peculiar and uniform characters, differing from the Myrtaceæ in their alternate leaves without pellucid dots, and in the nature of their inflorescence and fruit. They are trees, frequently of large size, rarely low shrubs, all delighting in running streams, some growing in estuaries or along the sea-shore. The author describes the characters of the order in considerable detail, and gives the diagnosis—in many cases redrawn from actual examination—of each genus and species. The number of genera he makes to be ten. The paper was accompanied with drawings illustrating the floral and carpological characters of each genus.—Note on the occurrence of fairy rings, by Dr. J. H. Gilbert, F.R.S. This paper was founded on the observations made by the author and Mr. Lawes on their experimental plots at Rothamstead. After some particulars as to the effect of different manures in varying the proportion of different kinds of vegetation in permanent pasture, especially grasses and Leguminosæ, the author suggests that the determination of the source of the nitrogen in the fungi that constitute the fairy rings which frequently make their appearance on the plots would throw some light on the much-disputed question of the source of the nitrogen of the Leguminosæ. It is remarkable that although, according to published analyses of various fungi, from one-fourth to one-third of their dry substance consists of albuminoids or nitrogenous matter, and 8 to 10 per cent. of mineral matters or ash, of which about 80 per cent. is potassium phosphate; yet the fungi develop into "fairy rings" only on the plots poorest in nitrogen and poorest in potash. The questions which appear still to require solution are these:—(1) Is the greater prevalence of fungi under such circumstances due to the manurial conditions themselves being directly favourable to their growth? or (2) Are the lower orders of plants—in consequence of other plants and especially grasses growing so sluggishly under such conditions—better able to overcome the competition and to assert themselves? (3) Do the fungi prevail simply in virtue of the absence of adverse and vigorous competition, or to a greater or less extent as parasites, and so at the expense of the sluggish underground growth of the plants in association with them? or (4) Have these plants the power of assimilating nitrogen in some form from the atmosphere; or in some form or condition of distribution within the soil, not available, at least when in competition, to the plants growing in association with them?—On a possibly wild form of *Hibiscus Rosa-sinensis*, by Prof. Oliver, F.R.S.

Mathematical Society, June 10.—Prof. H. J. S. Smith, F.R.S., president, in the chair.—Prof. Cayley, F.R.S., made a brief communication on some figures of curves in 3-bar motion.—Prof. Sylvester, F.R.S., spoke on "James Watt's parallel motion," and on an apparatus for regulating the motion of a train of prisms.—Mr. T. Cotterill read a paper on the correspondence of points collinear with a fixed origin. In the paper S and T are taken homogeneous functions of any number of variables (say three, $x\ y\ z$): the degree of S being one lower than that of T, and are supposed to be connected with another set, $x'\ y'\ z'$, of the same number of variables by the equations $\frac{x'}{x} = \frac{y'}{y} = \frac{z'S}{T}$. If the variables $x\ y\ z$, $x'\ y'\ z'$, denote the coordinates of two points in a plane, a correspondence is established between them depending on the forms of S and T. The object of the paper is to explain the relations between the corresponding curves and to give examples.

Physical Society, June 12.—Prof. Gladstone, F.R.S., president, in the chair.—Lord Lindsay, Sir W. Thomson, and Prof. Sylvester were elected members.—Mr. Wildman Whitehouse described some experiments he had made on the electric conductivity of glass. He employed pieces of thermometer tube about an inch in length, into the bore of which two platinum wires were inserted in such a manner that there was an interval between the points. In some cases one wire of platinum occupied the entire bore of the tube, and this tube was surrounded on its external surface by a helix of wire of the same metal. In each case the arrangement was introduced into a circuit in which were also placed a Thomson galvanometer and a set of resistance coils. It was shown that at the ordinary temperature there was no deflection, but that the current passed freely when the glass was heated to redness. The difficulty of making contact with the glass led Mr. Whitehouse to use two test-tubes, one inside the other, both containing mercury, with which wires of platinum freely communicated. The flame of a Bunsen burner was applied to the outer test-tube and the temperature of the metal noted by the aid of a thermometer. In one series of experiments the diameter of the internal tube was $\frac{5}{8}$ inch, the length in contact with the mercury about $3\frac{3}{4}$ inches, and the thickness of the glass $\frac{1}{100}$th of an inch. A current was first observed to pass at 100° C., and, as the temperature rose, the amount of deflection increased. The following are approximate measurements of the resistance of the glass at different temperatures:—

At 165° C. Resistance = 229,500 Ohmads
" 185 " " = 100 000 "
" 210 " " = 69,000 "
" 255 " " = 22,500 "
" 270 " " = 9,000 "
" 300 " " = 6,800 "

Prof. Gladstone drew attention to the necessity for ascertaining the nature and composition of the glass.—Prof. Guthrie alluded to the fact that electricity of high tension is freely conducted by glass at a red heat. He also asked whether, as the temperature was raised, a point was reached at which the conductivity began to decrease.—Prof. M'Leod pointed out that the thermometer tubes used by Mr. Whitehouse were of lead glass, and that the lead had in most cases been reduced by exposure to the flame of the Bunsen burner, and he urged that these facts should not be overlooked in measuring the resistances. He stated that lead glass is better than other kinds of glass for insulation.—Prof. G. C. Foster asked whether an increased capacity due to the heating might not introduce an error into the measurements of resistance. Mr. Whitehouse replied that he had only recently commenced the experiments, and promised that the suggestions which had been made should receive due attention.—The President then read a paper on the time required for double decomposition of salts. It is well known that if, on mixing solutions of two salts, MR and $M'R'$, an insoluble body can be produced by an interchange of metals and radicals, that body is produced to the fullest extent possible. The only explanation of this fact which has been given is founded on the theory of Bertholet, that in all cases of mixture there is a redistribution of the constituents according to their relative affinity and mass, with the production of more or less MR' and $M'R$. Now, if one of these, say MR', be insoluble, it will remove itself at once from the sphere of action, but this will necessitate a fresh distribution of the constituents with the production of more insoluble salt, and so on until the whole of the M has entered into combination with R'. Dr. Gladstone commenced this research twenty years ago, and added in a note to a paper in the Phil. Trans.: "It is easily conceivable that when the affinity for each other of the two substances that produce the insoluble compound is very weak, the action may last some time and become evident to our senses. Is not this actually the case when sulphate of lime in solution is added to nitrate of strontia, or carbonate of soda to chloride of calcium, or an alkaline carbonate to tartrate of yttria, or oxalate of ammonia to sulphate of magnesia, &c.?"—The President gave several experimental illustrations of the time required for double decomposition. He showed that ferric chloride and sulphocyanide of potassium react instantly, that citrate of iron and meconic acid, chloride of platinum and iodide of potassium, react gradually. The rate of change really depends on the degree of rapidity of the inter-diffusion of the salts. It is also affected to a very great extent by temperature. The following numbers illustrate the rate at which sulphate of strontium is deposited on the addition of sulphate of calcium to a solution of nitrate of strontium. :—

Cloud		in	4	minutes
0·071	grms.	,,	20	,,
0·130	,,	,,	60	,,
0·303	,,	,,	110	,,
0·497	,,	,,	170	,,
0·659	,,	,,	1270	,,

The total amount of salt which could be formed being 1·5 grms.

Astronomical Society, June 11.—Prof. Adams, president, in the chair.—Mr. Lecky explained the use of two ancient instruments he had given to the Society. The smaller one was known as a night dial; it was used about the end of the sixteenth century for finding the time at night by the position of the pointers of the Great Bear. The observer stood with his face to the north, and the instrument was held in one hand, so that a line upon it was by estimation vertical to the horizon; and with the other a moveable arm like a clock hand was turned until it was parallel to the direction of the pointers. The time was then read upon the circumference of a boxwood circle, which had to be set afresh for every night of the year. The other instrument was a Backstaff, which was used at sea until the invention of the sextant for determining the sun's altitude. The observer in using it stood with his back to the sun (whence its name), and he measured the arc between the sun's place and the opposite horizon through the zenith. The instrument which was in use before this was a very simple contrivance, being merely a pole along which a moveable bar at right-angles was shifted, until the cross-bar subtended the same angle when looked at by the observer with his eye at the end of the pole as the sun's altitude. Such contrivances were called Forestaffs, and were in use at sea until 1591, when Capt. Davis invented the Backstaff.—Mr. Marth exhibited a drawing of the orbits of the satellites of Saturn as they will be seen from the earth about the middle of August next, when there will be a conjunction of the satellite Iapitus with the ring and ball of Saturn. Mr. Marth was anxious that observations of this conjunction should be made by the possessors of large telescopes, in order to afford data for the improvement of the theory of the satellites of Saturn.—A paper was read by Mr. Knobel on an instrument for determining the magnitudes of stars.—Mr. Christie said that the probable error in determining the magnitude of a star with his photometer amounted to only the twentieth of a magnitude, but that the probable error varied for stars of different colours, owing to the effect of contrast with the light of the sky, which caused a red star to be more easily distinguished when its light was diminished than a star with a blue tinge.

Anthropological Institute, June 8.—Col. A. Lane-Fox, president, in the chair.—Capt. Richard F. Burton, H.M. Consul at Trieste, read two papers on Ancient Remains in Dalmatia, viz., "The Long Wall of Salona" and "The ruined cities of Pharia and Gelsa di Lesina." Salona was the Roman metropolis of Dalmatia, of which southernmost province of Austria, Spalato was at present the natural, and Zara the artificial and political capital. The "long wall" was of doubtful and debated origin, and a reference to numerous ancient and a few modern writers on it was made to show the obscurity in which it still remains. The author gave an account of his explorations, with detailed measurements of the ancient structure, called by some "Cyclopean," and especially pointed out the great variety of stone dressing it presented, which would afford valuable evidence in determining the style and perhaps the date of the work. His conviction that the long wall of Salona was Greek and pre-Roman rested very much upon the fact that similar constructions exist in the neighbourhood. In the island of Lesina the two ruins visited and described by Capt. Burton presented a remarkable resemblance, amounting almost to identity, to the long wall of Salona, and suggested that they were all the work of a single people, and that people not the barbarous Illyrians, but the comparatively civilised Greeks. Only two flint implements had been found, and those were discovered at Salona, near Spalato. The exploration of the Dalmatian Islands was attended with much difficulty; the scarcity of water was an evil to be met, and a Slavic guide was necessary unless the traveller could himself speak Slavic, for the inhabitants all belong to that race. The islands never having been previously explored (as far as the author was aware) by Englishmen, there was a large field of research for the antiquarian as well as the more general anthropologist.

PARIS

Academy of Sciences, June 7.—M. Frémy in the chair.—The following papers were read:—On the different effects produced by the same temperature upon the same species of plants, in the north and in the south, by M. A. de Candolle.—Researches on magnetic rotatory polarisation, by M. Henri Becquerel.—On a new method and a new instrument for telemetry (quick measurement of distances), by M. Giraud Teulon.—On the transformation of the camphor of *Laurineæ* into camphene, and reciprocally of the camphenes into camphor, by M. J. Riban.—A note, by M. J. Ponomareff, on thiammeline, a new derivative of persulphocyanogen.—On the dissociation of sulphocarbonate of potassium in the presence of ammonia salts, by M. Rommier.—On the theory of revolution surfaces which, by way of deformation, can be superposed on one another, and each on itself in all its parts, by M. F. Reech.—Communications on Phylloxera, by several gentlemen.—Several papers of minor interest, competing for the prize of Medicine and Surgery.—On the geographical position of the island of St. Paul, by M. Mouchez; he finds the latitude to be 38° 42′ 50″·796 S. (with a probable error of 0″·03), and the longitude, 5h. 0m. 49s. (probable error, 4s.).—On fluorene and the alcohol derived from the same, by M. Ph. Barbier.—Researches on taurine, by M. R. Engel.—On the bibromide of angelic acid, by M. E. Demarcay.—On three observations of accidents from lightning, by M. Passot.—Analysis of the mineral coal of the Suderoe Island (one of the Faroes), by MM. Bechin and Ch. Mène.—Remarks by M. Tresca, on a projected atmospheric post between Paris and Versailles.—A note by M. Emm. Liais, on the parallax of the sun.—M. Vibraye then drew the Academy's attention to the apparition of a destructive hemipterous insect in the vineyards of the Loir et Cher Department. The insect is very similar to *Phytocoris gothicus*.—Remarks by M. J. de Cossigny, on waterspouts.—On a new propeller of steamships, by M. E. Lehman.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Encyclopædia Britannica, 9th edit., vol. ii. (A. and C. Black).—On the Principles and Management of the Marine Aquarium: Wm. R. Hughes, F.L.S. (John Van Voorst).—The Life and Growth of Language. International Series: W. Dwight Whitney (Henry S. King and Co.)—First Annual Report of the Yorkshire College of Science, Leeds.—The Positive Philosophy of Auguste Comte: freely translated and condensed by Harriet Martineau. 2 vols. (Trübner)—The Geological Evidences of the Antiquity of Man reconsidered—an Essay by Thos. Karr Callard, F.G.S. (Elliot Stock).—Corals and Coral Islands: Jas. D. Dana (Sampson Low and Co.)—An Introduction to the use of the Mouth-Blowpipe: Scheerer and Blandford (Frederic Norgate).

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THURSDAY, JUNE 24, 1875

CROLL'S "CLIMATE AND TIME" [*]

Climate and Time in their Geological Relations; a theory of Secular Changes of the Earth's Climate. By James Croll, of H.M. Geological Survey of Scotland. (London: Daldy, Isbister, and Co., 1875.)

II.

MR. CROLL'S own theory about the distribution of heat by means of ocean currents is in intimate connection with his ideas as to the variation of climate in past time. His theory may be summarised as follows:—The Gulf Stream and other warm or cold currents are due entirely to the prevailing system of winds, which force the water along the surface, or even make it take a lower course; the return of the colder water from the Arctic regions being assisted by the difference of level caused by driving up the waters into a narrow basin, such as he supposes those regions to be. The result of this theory is, that if one hemisphere is colder than the other, the trades on that hemisphere will be strongest, and the resulting warm current will flow into the warmer hemisphere; any difference, therefore, in the mean temperature of one hemisphere from that of the other is augmented according to this theory by ocean circulation, whereas on Dr. Carpenter's theory the latter would have a counteracting influence. When, however, we take both theories into account, and also the effect of the distribution of land and sea, which is remarkably manifested by the two facts of the South Atlantic being coldest and the North Pacific also coldest, we see that we are not in a position to estimate the effect, if any of much consequence, of the different forms of ocean circulation on the occurrence of a glacial epoch, but must look for the causes of the latter independently.

Now what are the known facts to be explained? They are well described in various parts of this book, and the proofs of the less known are carefully given. We have first the widespread indications of a sheet of land ice in the northern hemisphere, reaching in some parts far down into temperate, if not into tropical regions; secondly, similar indications in the southern hemisphere during the same geological period, but without any proof of their being contemporaneous even in centuries with those in the northern; thirdly, a much milder climate than at present prevailing in very high latitudes in comparatively modern geological periods, though anterior to the glacial epoch; fourthly, that these changes from more intense cold to more intense heat have been going on throughout the whole of geological time; and lastly, that in the midst even of the glacial epoch, warm interglacial periods occurred. No satisfactory theory of the cause of the glacial epoch can leave any of these facts unaccounted for, still less contradicted. Sir Charles Lyell's theory, referring it to an alteration of the distribution of land and sea, does not well adapt itself to the magnitude of the phenomena indicated above in the first and second facts, and requires very sudden and violent changes to account for the fifth; and, moreover, it is shown by Mr. Croll that the distribution he indicates would have the very opposite effect to that supposed; geologists are therefore driven, however reluctantly, to consider the action of cosmical causes. Four theories founded on such causes have been proposed.

The first, that the solar system was passing through a cold region of space, may be dismissed at once; the second is that the sun is a variable star, and therefore the amount of heat received from him is variable; the third is, that the glacial epoch was due to a great obliquity of the ecliptic; and the fourth, Mr. Croll's, is that it depended on an increased eccentricity of the orbit combined with aphelion winters. We will discuss the last theory first, and examine Mr. Croll's proofs of it. In order to show how the eccentricity has varied in past time, and to find the periods at which it was a maximum or minimum, Mr. Croll has calculated by means of Leverrier's formula what its amount has been or will be, from 3,000,000 years past time to 1,000,000 years in the future, for intervals of 50,000 years, and has given a diagram and tables to illustrate the result. This must have been a most laborious task, but we are sorry to say that the results require confirmation. We have repeated the calculations for two of the most remarkable dates, near which the change is represented by Mr. Croll as very rapid from a maximum to a minimum, viz., 850,000 and 900,000 years ago respectively, and find that at the former date the eccentricity was ·0697 instead of ·0747, and at the latter date was ·0278 instead of ·0102 as expressed in the table. To satisfy ourselves that the mistakes are Mr. Croll's and not ours, we have recalculated also one of Mr. Stone's and one of M. Leverrier's results which have been used by Mr. Croll for the completion of his table, and in both instances have exactly verified them. The fact that the eccentricity was large when he represents it so, and small when he makes it small, seems to indicate that some approximating progress has been followed, and that possibly his diagram may give a *rough* idea of the changes of eccentricity for past time, provided of course that we agree to Leverrier's formula being used for such remote periods.

Assuming, however, that at some past date the eccentricity of the earth's orbit approached its maximum value, and that at the same time the winter of one hemisphere occurred in aphelion, what would be the result? In the first place the total annual heat received from the sun, which varies inversely as the minor axis of the earth's orbit, would be slightly increased, but not sufficiently to have much effect upon climate. The more important result would be that the hemisphere whose winter was in aphelion would have it very rigorous, and its summers would be very hot, while the other hemisphere would be enjoying a perpetual summer. It is on this that Mr. Croll relies for producing a glacial epoch, and we see that it involves the statement that the two hemispheres were *not* glaciated at the same time, while the other theories assume that they were.

Our question therefore is: Will an extreme difference between the winter and summer temperature produce a glacial epoch? The actual amount of heat received by either hemisphere may easily be shown to be the same, whether there are great or little differences between summer and winter, whether as to their length or their intensity, so that a glacial epoch could not be the *direct*

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[*] Continued from p. 123.

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result, and we must look to the indirect effects. While agreeing in the existence of many of those pointed out by Mr. Croll, we cannot think it quite so settled a matter as he does, as they do not all act in the same way. In the first place, though the total amounts of summer and winter heat together are equal in the two hemispheres, yet, since a larger proportion of the greater summer heat is *available* than of the smaller winter heat, the more unequal these are, it follows generally that *more* heat must be obtained, and therefore the more uniformly heated hemisphere will be coldest; but secondly, as Mr. Croll states, we must consider the formation of snow, *i.e.* take into account the latent heat of water and other physical properties. Some of his arguments on this point are rather circular, for whatever amount of heat is rendered latent in the melting of ice, as much will be supplied to radiation in the freezing; and no *increase* of ice would arise from this. There are, however, two points that seem to be made out. First, that snow and ice are better reflectors of light than almost any other substance, and therefore less heat enters into them; and, secondly, that moist air is much less transparent to heat than dry, so that the vapour raised by the sun in summer would be an *opposing* influence, whereas the frozen vapour in winter when fallen as snow would leave the air above freer for radiation. This result would overbalance that spoken of in the first place, and be a powerful influence in the production of a glacial epoch. The vapour, too, that was raised in summer would come in a large degree from the warmer tropics, and therefore continue to add each winter to the mass of the snow and ice in the more polar regions.

These seem to us to be among the most convincing of Mr. Croll's arguments, and they are in agreement, as he shows, with the condition of the earth at the present time as regards the more glaciated condition of the southern hemisphere, and they agree with what has been pointed out by Prof. Tyndall, that heat, to bring the snow in form of vapour, is just as necessary for a glacial epoch as cold to freeze it when brought. It has been argued by Mr. Murphy that under exactly the same circumstances it would be the more equally heated hemisphere that would be glaciated, as the cool summer would melt less snow; but according to the above theory the summer of the other hemisphere, though naturally hotter, would also be rendered cool at the earth's surface. We see that the whole of this argument depends on the relation of the atmosphere to heat rays, and what has been stated above has been experimentally verified; yet we are far from being fully informed on this point, and the example of the planet Mars, which is almost exactly under the circumstances of great eccentricity and winter aphelion supposed above, and yet has not much glaciation, teaches us that this may depend on other combinations of circumstances beyond those we have considered above.

The glaciation, Mr. Croll thinks, would be assisted by the deflection of ocean currents, on which he accordingly spends his strength; but the vertical circulation of Dr. Carpenter, no less proved than the influence of the Gulf Stream, would be antagonistic to this, and we may safely leave the unknown residuum out of consideration.

Such is Mr. Croll's theory of the cause of the glacial epoch, to the illustration of which he brings forward many interesting facts. Among these are the proofs he gives of the occurrence of warm interglacial periods. Some of these proofs are collected from other writers, but many are from his own observations, and consist of the intercalation of beds of fossiliferous sand between two masses of boulder clay, the fossils being often of a southern rather than of a northern type. He also refers to the records of borings collected by him and already published, which showed, in several instances, three, four, or even five boulder clays in succession, separated by stratified sands. These interglacial periods are certainly more easily accounted for on Mr. Croll's theory than on any other, as, owing to the numerous terms on which it depends, the eccentricity of the earth's orbit is liable to rapid changes. Many of the instances, however, of interstratified fossiliferous sands seem too insignificant to require so vast an apparatus as a cosmical cause to account for them; rather are they evidences of the dependence of temperature on the atmosphere, whose changes are much more comparable to those of limited beds. Another set of facts adduced by Mr. Croll in illustration of his theory is the evidences we have of glacial conditions in former geological periods, of which he gives a very useful summary, though it seems to us he goes too far in taking proofs of a *warm* climate to indicate glacial epochs preceding and succeeding it, on the ground that all warm periods *must* be interglacial—this is *lucus à non lucendo* truly. Indeed, the warmth of North Greenland in the Miocene period seems to us one of those facts which are not satisfactorily accounted for by the theory—for the eccentricity has seldom been much less than now—and our northern winters are in perihelion.

He thinks he can identify the glacial period proper, and those of the Eocene and Miocene periods, with portions of past time when the eccentricity has been great and yet rapidly changing to small; and attempts thus to get a measure of the length of a geological period, and hence with the aid of other theories and supposed measurements to arrive at the total length of past geological time. These speculations may be ingenious, but they can give no assistance to the solution of a problem of which we really have not yet the data. The title of the book leads us to believe that all the discussion about the glacial epoch is engaged in only to lead up to this, but we must regard that as a much more manageable and therefore interesting problem, and turn now to examine the other theories that have been broached to account for it.

The theory of the sun being a variable star is not in such an advanced state as to warrant a complete discussion from this point of view, and we have seen that mere absence of heat can never cover the land with snow and ice, and this theory therefore may be dismissed.

The only remaining one is that which accounts for it by increased obliquity of the ecliptic. This theory, which has recently been broached in different forms by Lieut.-Col. Drayson and Mr. Thomas Belt, has been espoused by Mr. Woodward in his address to the Geologists' Association, whose paper has been deemed worthy of insertion in the "Arctic Manual." Col. Drayson's form of it, which imagines that the whole mass of ice was formed every winter and melted every summer, may be dismissed as absurd. Not so Mr. Belt's. There can be no doubt that an increase in the obliquity of the ecliptic would cause a greater difference in the seasons, and this difference we have seen to be the very basis of Mr. Croll's own theory; the results must be the same (and they are rightly seen by Mr. Belt), whatever may be the *cause* of the difference between summer and winter temperature. If this theory were the true one, it is plain that both hemispheres were glaciated at the same time, so that both theories cannot be true; but the matter of fact as to the synchronism or otherwise of the glaciation of two hemispheres can never in the nature of things be determined. But we have still left the question, Has there been or can there be any great change in the obliquity? Astronomers say no. Mr. Belt, however, thinks that the distribution of sea and land and similar causes *may* make it possible for greater changes to occur—a gratuitous supposition that Mr. Croll shows to be groundless. This cause, then, though it may have the general effect of lowering the temperature of temperate and Arctic regions, is not sufficient to cause a glacial epoch.

On the whole, then, there appear to be several independent cosmical causes which affect climate in a greater or less degree, and the probable truth is that a glacial epoch occurs when they all conspire to bring about the same result.

So far, by going from chapter to chapter, we have endeavoured to bring Mr. Croll's arguments into something like logical order. The remainder of the book scarcely admits of this; indeed, we think the author might well have bestowed more care in arranging his matter if it was intended to form a consecutive whole; as it stands, there is much that can only be called a miscellaneous collection of essays without any obvious connection. Among these are his accounts of observations on the North of England ice-sheet, and his speculations as to the direction of its motion. There are also two theoretical questions of great interest discussed—"The physical cause of the submergence and emergence of the land during the glacial epoch," and "The physical cause of the motion of glaciers." With regard to the first of these questions, there are undoubted proofs that great oscillations of the relative level of land and sea have taken place in recent geological times, and the question arises, Was it the land which sank and rose, or the sea which changed its level? It was rightly considered one of the grand discoveries of geology when it was first taught that the changeable sea was that which retained its constant level, and that the "eternal hills" had been but as yesterday beneath the waters; and this principle is not likely to pass away. By it all alterations of level have been ascribed to the motion of the land, and none to the rising of the sea. While agreeing, however, to the principle, we may doubt its universality, and may be prepared to entertain the question whether causes of limited extent may not operate to raise the level of the sea, and thus enable us to account more naturally for such rapid changes as are sometimes indicated. There can be no question but that any considerable amount of water which by the fact of freezing should be retained in either polar region, and form an ice-cap there, would correspondingly shift the earth's centre of gravity and draw the remaining water more over to the side on which the ice-cap lay; and the amount of elevation of sea-level might easily be calculated for any latitude, if we knew the extent of the cap and its manner of deposition, *i.e.* its shape; and the amount would be doubled if the ice-cap were first on one hemisphere and then transferred to the other. This calculation Mr. Croll attempts to make on the very ingenious method of approximation that supposes the ice-cap such as shall make the earth with the cap on one side a perfect sphere. The question can be worked out more directly, as has indeed been done, though with varying results, the mean of which indicates that the rise at one pole due to this cause would be about one-fifteenth of the thickness of the ice melted off the other. If, therefore, we want to account for an alteration of level of 500 feet in England, corresponding to about 600 feet at the pole, we should require to have somewhat less than two miles' thickness of ice on the antarctic regions now. While these figures represent data too far removed from the truth to be at all reliable, and there are, moreover, other causes that may affect the result, they serve to show the kind of thickness required—that it is not *twenty* miles, for instance. Are we prepared, then, to admit that there may be two or three miles of ice on the south pole? This does not appear to us at all an extravagant assumption, when icebergs have been met with 700 or 800 feet out of water, and which must therefore have been considerably more than a mile in total height. We do not think it therefore unreasonable to suppose that during the glacial epoch, or indeed at other times, when there was less ice at the south pole than now, the sea in our latitudes may have stood at a higher level, and that many of the elevated marine deposits and raised sea beaches are due to this cause, and not to depression of the land; for the latter we have no other evidence, and it would involve such vast changes in so recent times that we can scarcely believe would leave all the main valleys and hills as they were before the glacial epoch, and afford no evidences of post-glacial faults. This argument of course does not deny that there *have* been land oscillations during the period, but only that they are not the only ones.

This leads us to the last of the theoretical questions discussed by the author of this work—the physical cause of the motion of glaciers, the answer to which appears to depend upon what is the amount of the shearing force of ice. The remarks which Mr. Croll makes on the theory and experiments of Canon Moseley are very forcible. There is no doubt that the element of time enters largely into the amount of force required to shear ice, and that during this time heat is acting on the ice also, and consequently that satisfactory experiments can only be made on a glacier itself; and also that the theory of the dependence of glacier motion on *change* of temperature will not account for the greater descent in summer than in winter. But what is Mr. Croll's own theory? He, like Canon Moseley, calls in the agency of heat, and indeed, since heat obviously makes a difference in the amount of motion, we have only to find out *how* it makes this difference to determine the cause of the whole motion. He considers the motion of a glacier molecular, that the heat entering at one end melts the first molecule, which then descends by its weight and leaves room for the molecule above it to descend, when *it* melts. This may look very pretty at first sight, but the first molecule would never descend and *leave a vacuum behind it;* so the second molecule must melt at the same instant, and so on to the other end of the glacier, which is absurd; and besides, what is there in this theory to distinguish a glacier from a common piece of ice? which on this principle ought to flatten out and not retain its shape as it does. Why also are we to suppose the molecule alternately to melt and crystallise when the heat is continuous? The mistake on which this explanation is founded seems to be the confounding of radiation with conduction. It is radiant heat that passes through ice, which is a very bad conductor. Ice at 32° F., heated by conduction, would certainly melt on the outside; the interior can only melt by the *absorption* of radiant heat. We cannot either understand the statement "that ice at 32° cannot take on energy from a heated body without melting," unless it is the exact equivalent of what we have just said; but then no heat could be transmitted, as it would be consumed in melting the ice, and if it were otherwise, still any amount of heat short of the latent heat of water might be "taken on" by a molecule without melting it.

We fear, then, that the complete account of the descent of a glacier is still a desideratum. The various theories may contain elements of truth, but none are entirely satisfactory.

As far as definite results are concerned, it will appear that Mr. Croll's book does not do all he hopes it may, yet we welcome heartily his attempts at reducing complex questions to arithmetical issues, for we thereby gain clearer ideas as to whereabouts the truth may lie, and certainly have the questions put before us in a more definite form. The vast problems with which he deals, and for the suggestion and discussion of which science is so largely indebted to him, are waiting for solution, and every attempt is valuable, both as showing us where to look and where *not* to look for help.

J. F. B.

SPRAGUE'S ELECTRICITY

Electricity; its Theory, Sources, and Applications. By John T. Sprague. (London: E. and F. N. Spon, 1875.)

THE author tells us in his preface that this book is "written chiefly for that large and increasing class of thinking people who find pleasure in the study of science, and seek to obtain a full and accurate scientific knowledge for its own sake, or as part of the necessary mental preparation for many of the departments of modern life." Our examination of the book itself would lead us to an opposite conclusion. We very much question whether any one of the class to whom the author refers will ever have the patience to read through this volume. Certainly they will have but sorry pleasure and anything but full and accurate information. The book abounds in foolish conceits advanced with a show of knowledge that cannot but repel every intelligent reader.

That we are justified in these strictures will be seen from one or two quotations. Here, for example, are some statements taken from chapter ii. in this book. At the outset the author asserts that the fundamental facts relating to frictional electricity given in "one of our standard electrical works (and it is just what all say) . . . are received as absolute truth by electricians . . . and yet there is scarcely a truth in them which is not overweighted by an error, and the simplest facts even are erroneously stated" (p. 17). Mr. Sprague, so far as we are aware, has never done anything to prove that he is able to sit in judgment on the intellectual giants among modern men of science. Mere off-hand condemnation of the laborious work of men like Sir W. Thomson and Prof. Clerk-Maxwell cannot for one moment be tolerated. Mr. Sprague seems to us to be like a child trying to turn one of the pryamids of Egypt upside down because he imagines it has been built the wrong way up. The best teaching is to let him try. This is how the author proceeds in his bold attempt. It is not true, he states, that bodies similarly electrified repel each other; "the repulsion is only apparent; the real cause of the motion is to be found in the attraction exerted by surrounding bodies" (p. 19). And with regard to the electrophorus, "that the dish forms the conductor from the dielectric to the earth, as all electrical books tell us, is an error which will come up for examination by and by" (p. 15).

According to Mr. Sprague the common explanation of induction is all wrong; "the real explanation is" given by him (p. 49). The rubber of an electric machine "is seldom made upon true principles" (p. 33); and as for the earth-connection to an electric machine, we are assured that it is merely imaginary; what we must do is to lead a chain to the floor or gas-pipe, and "hence the idea that we make a connection with the mass or surface of the earth" (p. 29). And further on (p. 40) we read—still concerning the machine—that "because both the poles are insulated and the circuits limited, we are freed from the *ignis fatuus* of the earth-connection." We presume the author does not mean the earth-connection is an *ignis fatuus*, but that the usual explanation is such; it is evidently so to him, for it has landed Mr. Sprague in a quagmire of crudities where we will not attempt to follow him. In these early chapters everything is attributed to "polarisation," a word which has for the author a consoling sound like that "blessed word Mesopotamia." We are told that it is for a similar cabalistic reason electricians employ the term "potential." Not understanding the term, and yet finding it necessary to say something about it, this is how the author discusses the subject: "The word [potential] is always used in place of tension or electro-motive force, because there is something full and smooth sounding about it; but the idea which really does belong to it is a pure mathematical abstraction which only highly trained minds can apprehend" (p. 154).

In another part of this book we meet with dark hints upon "Sprague's patent universal galvanometer," an instrument that is to "do for many purposes, without other instruments and without calculations, the work which at present requires the Wheatstone's bridge and expensive resistance coils, as well as many calculations." But, beyond exciting our curiosity, the author declines to go further, and so we cannot give our readers the benefit of this wonderful galvanometer, which combines "Pyscho" and "George Bidder" in one.

Notwithstanding the grave defects that quite spoil the early chapters in this book, it is only just to the author to point out that the latter part of the volume has considerable merit. Much useful practical information is to be found in the chapters on electro-metallurgy, a subject that is discussed with great detail, too much so, however, for a general treatise. The author has evidently been at no little pains to collect the numerous tables he gives, and in some instances they are the results of his own experiments. There is also a freshness and originality in the treatment of the sections on resistance and electromotive force that make us regret Mr. Sprague did not submit his theoretical views to some scientific friend before sending his work to the press. If the author had confined himself to the practical part of current electricity we should gladly have recommended his book to our readers.

OUR BOOK SHELF

Anales del Museo Publico de Buenos Ayres para dar a conocer los objetos de Historia Natural nuevos o poco conocidos conservados en este establecimento. Por German Burmeister, M.D., vol. ii. (Buenos Ayres and London: Taylor and Francis.)

IN previous numbers of NATURE (vol. iii. p. 282, and vol. vii. p. 240), we have given some account of the important work which the well-known German naturalist, Dr. Burmeister, is now carrying on at Buenos Ayres.

The number of the *Añales* now before us completes the second volume of this remarkable work, and gives us additional proof of the extraordinary richness of the extinct Mammalian Fauna of the Argentine Republic, to which Dr. Burmeister has devoted so much attention. The Monograph of the Glyptodonts, or extinct gigantic fossil Armadillos, which is now brought to a conclusion, is certainly one of the most valuable contributions to palæontological science that has been produced of late years, and deserves the hearty commendation of all naturalists. This is more especially the case when we consider the difficulties under which the work has been carried on—in a new country, where every man *avidus lucri* is striving to advance his own material interests, and science and all that pertains to it are at an utter discount. On one occasion, we have been told, when one of the most perfect of these Glyptodont skeletons came into the market, the authorities of the National Museum were unwilling or unable to raise the necessary funds to secure it, and it would have left the country and been lost to Dr. Burmeister and his Monograph, had not an English friend found the money. Then, again, the necessity of having the plates lithographed in Europe must add greatly to the difficulties of the undertaking. Under these circumstances we may fairly congratulate Dr. Burmeister and science on the occasion of the second volume of the Annals of the Public Museum of Buenos Ayres having been brought to a successful conclusion.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Peculiarities of Stopped Pipes, Humming-tops, and other Varieties of Organ-pipes

THE peculiarities of a stopped organ-pipe as compared with an open organ-pipe are many and suggestive, and are of the utmost importance to the investigator both to know and to interpret. Without entering deeply into the principles of the craft of organ-building, there are certain matters of fact very necessary to be known before the full bearing of a theory can be estimated or its consistency be judged with true understanding.

By far the greater portion of an organ consists of pipes of the structure called "flue-pipes," or, as here named, "air-reed" pipes, and these are of two classes, the open and the stopped; also they are of two kinds, wood and metal. We have to notice how differently these two kinds are constructed to attain the same ends. In the metal pipe every part is to all appearance immoveable. In the wooden pipe the under-lip, or technically the "cap," is the only adjustable part, and is fixed in position by two or more screws. Within the mouth there is a platform filling the space beyond the windway; it is called the "languid," and it is by varying relatively the level of the edge of the cap to the edge of the languid that the direction of the stream of air is determined; if the cap is set low the angle of flow outward is increased, contrariwise it is lessened, and the art of the voicer decides to the finest degree what is requisite for the quality and speech of each particular pipe. If the wind is much thrown outwards, the speech is slow; if more inward, the speech is quickened; if too much inward, the octave sounds instead of the ground-tone; if too much outward or inward, the pipe will not speak at all. One more power of adjustment remains—the width of the narrow slit through which the wind issues is capable of being varied by alteration of the inner surface of the cap; a wide windway gives a stiffer air-reed, a fine windway gives a thinner one. In a metal pipe we have precisely the same capability of variation, only that we effect our purpose by pressure; the languid is moved higher or lower, not the cap. By means of a rod introduced at the foot or at the top of the pipe, we tap or press the languid into the desired relation to the edge of the underlip. We can also press the upper lip forward or backward; we can, by a like process, reduce the windway or enlarge it as easily. Very simple, yet very beautiful, compensations. In the variations of construction, nothing is done without purpose, nor can you make any one of these minute changes without causing at the same time a flattening or sharpening of the pitch, or a diversity in intonation or quality.

The above details all tend to one point, which I wish to press upon your attention; one distinctive feature belongs to the stopped pipe: the languid is lower than in an open pipe, else the pipe does not attain its proper speech. Consider it well, for it is a fact full of meaning. A necessity of an opposite kind exists in the nature of an open pipe; its demand is that the current shall have determination more to an outward flow. The cause of so essential a distinction between the two classes of pipes will be explained in another paper.

Stopped pipes when they are deep-toned are called "Bourdons," the name the French give to the Humble Bee for its "drowsy hum." Our plaything, "the humming-top," is a true bourdon, is a revolving organ-pipe, has a vibrating air-reed, its principle of action is "suction by velocity," the abstraction of air particles by velocity of *rotation* causing a partial vacuum just as in the stationary organ-pipe by velocity of *passage* of a current of wind.

Bearing in mind the working power of the air-reed, we are brought to consider the effects of the dimensions of the pipe and consequently of the form as well as the extent of the air-column whereon this power is impelled to act, and it is necessary to recur in passing to the question of length. Scientific writers affirm that the length of an organ-pipe for a given note corresponds to the length of the wave in air with an absolute relation, thus expressed. Prof. Tyndall says: "The length of a stopped pipe is one-fourth that of the sonorous wave which it produces, whilst the length of an open pipe is one-half that of the sonorous wave." Prof. Balfour Stewart says, in his "Elementary Lessons in Physics": "In an organ-pipe of this kind, the upper end closed, the primary note is that of which the wave length is twice the length of the pipe . . . the wave length of the sound produced by an open pipe is equal to the length of the pipe, so that it is only half of that produced by a shut pipe of the same length." (One is curious to know why there is this difference of statement from two leading teachers of men; perplexing to the student in want of a leader). Prof. Tyndall demonstrates his affirmation, showing that a stopped tube resounds to the note mid C of 256 vibrations per second; the wave length in air of this note he states to be fifty-two inches; then in proof he measures the jar or tube, and says, "by measurement with a two-foot rule I find it to be thirteen inches, precisely a fourth of the wave length." He then proceeds to affirm the same of organ-pipes, and proves it by tuning-forks and by sounding the pipes to the same note, and believes he has justified his assertions. His hearers do him that justice, and go home believing also. The proof is, however, altogether illusive. No speaking organ-pipe of that length ever gave the note of that pitch. Let us put the assertion to the test. My object lies beyond the rectification of a philosopher's misapprehension, and is meant to show not only that an organ-pipe behaves itself in a manner different to that with which it is accredited, but also why it does so; to show how important a matter in the nature of its action is this neglected difference, and how wide its bearing on the whole system of musical instruments. Here at my hand is a stopped pipe sounding mid C. I measure it interiorly from languid to stopper; it is eleven inches in length, and has a diameter of one-and-a-half inches. Here is an open pipe, same pitch, same diameter, and its length is twenty-three inches. Observe, our stopped pipe is half an inch less in length than half that of the open pipe; yet again notice, it is longer than that pipe would be if severed at the true nodal distance from the languid. How can we read eleven as precisely thirteen, and twenty-three as twenty-six inches? Under the strange notion that it is no matter if there is a difference, this has been done, and the truth of facts lost sight of or disguised in the convenient phrase, "approximately correct." The phrase assumes that there is a standard claiming nature's allegiance. We want to know, not what is correct, but what is true? Further, remark that if you stop the same open pipe at the top, the note obtained will not be an octave deeper, it will be nearly a tone sharper than that; if you stop the pipe at the centre, the note will not be the same as the open one, it will be considerably flatter; in neither case a good tone, since for its proper sounding in such condition the lip would require to be cut higher, mouth a little narrower, perhaps curved, and languid lowered. Every detail we come upon tells plainly of the working power of the reed affecting variably the results in pitch, and I think the reason for these distinctive sounding lengths will be discerned when we reach the consideration of the question of periods of vibration in pipes as tempered by rests.

The fundamental importance of the recognition that pipes of the same pitch varied between themselves as to lengths, was not perceived, nevertheless a qualifying condition was admitted that pitch was "affected by *depth* of the pipe, that is, its distance from front to back, but *width* does not affect pitch." As regards "depth," in no work within my knowledge does there exist any attempt at a solution of the problem how such a result ensues that depth interferes with pitch. It seems to be taken account of only as a disturber of the harmony of things, yet see how significant it is under the new theory of the working abstracting reed. The actual law operating admits of most precise statement when this generating power is acknowledged, viz., the difference of pitch in pipes of varied diameter (other things being equal) is proportional to the difference existing between the area of the cross-section of the pipe and the area of the mouth; the difference in pitch is greatest when the depth from front to back is greatest. It should be observed that increase of depth always flattens pitch, and tends to deprive the pipe of harmonic force. As regards the further assertion that "width" is without effect on pitch, this also is inexact and misses the very point which should have led to closer investigation. It is not true, because the same amount of wind acting over a wider area cannot do the larger extent of work with the same energy. The pitch of every pipe is affected by the width of mouth *relatively*, that is to say, its proportion to the diameter of the pipe. Apart from the ordinary rectangular and cylindrical pipes there are others of so-called "irregular shapes," which are usually viewed as monstrosities, out of the pale even of law padded with exceptions; yet these we shall find are the best evidence to us of the uniformity of the principle of action set forth in these papers, and of the consistency of a theory which recognises no exceptions.

Cylindrical pipes, notwithstanding their symmetry, differ greatly among themselves. The law by which flue-pipes differ has never yet been noticed, which is singular, since it is very striking when the pipes are thoughtfully observed, and gave the first clue to the theory of an aréo-plastic reed. A student well read in all that the best text-books in acoustics can teach, coming to the practical study of organ-pipes, and seeing in a grand organ so multitudinous an array of pipes, the unison pipes of the several stops conspicuous for diversities of diameter as well as of length, would naturally expect that here, if anywhere, he would find confirmation of Reynault's law, "The velocity of propagation of a wave of the same intensity in straight lines *is less according as the section of the tube is less*." No! this small comfort is denied him; he is in a world of contrarieties; the law is abrogated; he will find the organ world *de facto* governed on principles the exact opposite, "*The velocity is greater as the section is less*." Investigating further, he will find that, although in length the octaves of particular flue-stops examined are each very closely upon half the length of the other, yet their diameters do not follow a similar rule, for instead of octave or double octave being in that ratio, he must from the pitch note count to the seventeenth pipe before he will arrive at a pipe half its diameter. For other seeming anomalies, let him proceed to the stops called bassoon, trumpet, and tuba, and he will find that here increase of diameter demands not less length, but greatly increased length, to accompany increase of scale. Books of latest authorities will tell him that in an organ-pipe with a metallic reed "the note produced depends upon the length of the pipe rather than upon the length of the reed. In fact, when the note is established the reed obeys the impulses it receives from the air in the tube. Its use is accordingly rather to economise air and to give certainty and percussion to the striking of the note." Alas, it is inference by theory without test. Remove the whole of the eight or nine feet of the tube, leaving but the few inches of cup or socket, and you will have altered the pitch not more than a semitone.

All organ-pipes having metallic reeds act in conformity with Regnault's law, and the same holds good of wind instruments—trumpets, bassoons, and the like. All organ-pipes possessing air-reeds, flutes also, and some whistles, not all, display an opposite law. The musical tones of all in both these systems are the result of "suction by velocity," and the distinction is that in the former the intermittence is produced by suction under a *propulsive current*, and in the latter by suction under an *abstracting current*. The fact announces the law and leads to its explanation.

HERMANN SMITH

Faults and the Features of the Earth

MY attention has been drawn to an article in NATURE, vol. xii. p. 93, on an exploring party of the Geological Class of the University of Edinburgh to trace out a long fault in Scotland. In this it is stated that particular attention was devoted by the party to the connection between dislocations and valleys, and they came to the conclusion that not a single main valley ran along the fault they were tracing out. As an advocate of the theory *that faults or other breaks greatly induced the present features of the earth*, perhaps you may allow me to say a few words on the subject.

Fault-rock may be friable or hard; the first is inclined to induce valleys, the second peaks or ridges. Faults are of different ages, and therefore the features due to them are liable to be obliterated. Pre-Silurian features may be obliterated by the subsequent deposition of Silurian rocks, and so on upwards until we find many preglacial features obliterated by the glacial drift. In Ireland and Scotland we find more faults in the metamorphic rocks than in the overlying Silurians, in the Silurians than in the overlying Carboniferous and Old Red Sandstone, and in the Carboniferous than in the drift, while each newer accumulation obliterated, or perhaps, more properly, obscured the features in the older.

The fault examined by this party, from the brief description, seems, first, to have had a hard fault-rock, and second, its age to have been far from recent. Consequently, by the first, if the fault induced any features at all in the present surface, they ought to have been peaks or a ridge like that formed by the great Slieve-muck fault in Tipperary, Ireland; while if the second is correct, this fault ought not to form surface features, as any features due to the original fault were long since obliterated; also, the fault has been cut up and displaced by the more recent movements. If a valley chances to run along the line of an ancient fault, it probably was not induced by that fault, but by a much more recent break that for a greater or less distance coincided with the line of the older fault.

G. H. KINAHAN

Wexford, June 18

Salaries in the British Museum

AMONG your notes of last week is a favourable announcement of my promotion as an assistant in the Geological Department of the British Museum; but whilst thanking you, allow me to point out that it contains a grave misstatement as to the amount of remuneration I receive for my services (as a reference to the Parliamentary Returns will demonstrate); a misstatement alike unjust to the trustees and to myself.

May I venture to ask you to insert this, and so correct the erroneous impression which the paragraph conveys, as to the small amount of the pay received by myself and others in a similar position on the establishment.

British Museum, June 15 WM. DAVIES

OUR ASTRONOMICAL COLUMN

THE DOUBLE STAR Σ 2120.—In the notes to the last catalogue of measures of double stars of the late Rev. W. R. Dawes, he remarks with reference to Σ 2120, or, as it has been frequently called, Herculis 210 (Bode): "This object discovered by Struve is undoubtedly a binary system—the position varying in a retrograde sense, and the distance diminishing." Notwithstanding this positive opinion as to physical connection of the components by so high an authority in this department of practical astronomy, an examination of the path of the companion up to the latest published measures of the Baron Dembowski towards the end of 1870, or, it should be stated, through a period of observation fifteen years longer than that upon which the above opinion was expressed, does not support the presumed binary character of the object, but on the contrary, when the apparent fixity of the principal star is considered, shows pretty decidedly that the variation of angle and distance must be owing to proper motion of the smaller one. In fact we may represent the measures, from Struve's earliest in 1829, to Dembowski's in 1870, by the following expressions:—

$$d \sin P = -1''{\cdot}6806 - 0''{\cdot}12044\,(t - 1850{\cdot}0)$$
$$d \cos P = +1\ {\cdot}7259 - 0\ {\cdot}10250\,(t - 1850{\cdot}0)$$

which formulæ imply a secular proper motion of the small star amounting to 14″·75 in the direction 226°·0; they may doubtless be somewhat improved by complete discussion of all the measures, and perhaps some one of the astronomical readers of NATURE may be able to say how measures in the present year are represented.

D'Agelet, Bessel, and Struve have meridionally observed this star.

THE "MIRK-MONDAY" ECLIPSE, 1652, APRIL 7–8.—The following elements of this long-remembered eclipse are founded upon the same system of calculation which furnished so satisfactory an agreement between computation and observation in the eclipse of 1715, lately detailed in NATURE:—

Conjunction in R.A. April 7, at 23h. 4m. 33s. G.M.T.

	°	′	″	
R.A.	17	42	14	
Moon's hourly motion in R.A.		33	0	
Sun's „ „		2	18	
Moon's declination	8	24	17	N.
Sun's „	7	31	40	N.
Moon's hourly motion in Decl.		17	5	N.
Sun's „ „		0	56	N.
Moon's horizontal parallax		60	16	
Sun's „			9	
Moon's true semidiameter		16	25	
Sun's „		15	57	

The sidereal time at mean noon April 8 was 1h. 9m. 20s., and the equation of time 1m. 38s. subtractive from mean time. The middle of general eclipse April 7, at 22h. 21m. 30s.

Hence the following points upon the central line in its track over the north of Ireland and Scotland:—

	°	′			°	′			°	′			°	′	
Long.	8	25	W.,	Lat.	50	21	N.	Long.	4	8	W.,	Lat.	55	3	N.
„	7	50			51	0		„	2	47		„	56	28	
„	6	3			53	0		„	1	20		„	57	54	
„	5	26			53	42									

At Carrickfergus, where Dr. Wyberd observed the eclipse as described in the "Philosophical Transactions," totality began at 22h. 8m. 34s. according to the above elements, and continued only forty-four seconds. At Edinburgh it commenced at 22h. 22m. 55s., the duration being 2m. 47s. with the sun at an altitude of 39°; and at Arbroath at 22h. 26m. 23s. with the same duration, these being local mean times. Probably there may be other accounts of this eclipse in existence than those commonly quoted when "Mirk Monanday" is referred to.

DIAMETERS OF THE PLANETS.—We give the following values of the apparent diameters of planets reduced to the mean distance of the earth from the sun and of their true diameters in English miles, as being perhaps as reliable as any that can be assigned from existing data. They are founded in every case upon the measures which from observational circumstances appear to deserve the greatest weight, and in the reduction to true values the solar parallax is taken 8″·875, and Clarke's diameter of the earth's equator is adopted. It would of course be idle to attempt to offer final numbers, where the difficulties attending observations and the differences between the results of the most experienced and favourably-circumstanced observers are so considerable.

	″		Miles.	
Mercury	6·35	...	2,850	
Venus	16·95	...	7,550	
Mars	9·305	...	4,150	
Jupiter, Equat....	197·47	...	88,200	Compression $\frac{1}{15{\cdot}54}$
„ Polar ...	184·76	...	82,500	
Saturn, Equat....	166·82	...	74,500	Compression $\frac{1}{9{\cdot}10}$
„ Polar ...	148·50	...	66,300	
Uranus	68·57	...	30,600	
Neptune	67·26	...	30,050	

In fixing upon the apparent diameters of the bright planets it has been desired to adopt values which shall represent the actual arc values that are presented by the true diameters at the earth's mean distance. Many observations would assign larger values, but undoubtedly less trustworthy for computing real dimensions. As is well known, preference in such case is to be given to double-image over wire-micrometer measures, yet even if we confine ourselves to the former mode of observation we by no means secure great consistency of results.

SOLAR HEAT AND SUN-SPOTS

THAT the rainfall of certain parts of the earth tends to vary periodically with the sun-spots has been shown with considerable probability by Messrs. Meldrum and Lockyer, and Prof. Köppen * has detected a similar tendency in the temperature of the atmosphere, most distinctly shown (as might have been anticipated) at stations in the tropical zone.† These discoveries indicate that there is at least some ground for the truth of Sir W. Herschel's surmise, that the heat emitted by the sun undergoes a periodical increase and decrease, concurrently with the varying disturbance of the solar atmosphere, as evidenced by the number of spots and prominences on his surface. But except Mr. Joseph Baxendell, who has published two papers on the subject in the fourth volume of the Transactions of the Literary and Philosophical Society of Manchester (new series), I am not aware that anyone has attempted to investigate the more direct evidence afforded by observations of the black-bulb thermometer.

Mr. Baxendell's work was based on the observations of the Radcliffe Observatory at Oxford, and a series made at Eccles by Mr. Mackereth; the two series extending over the years 1859-66. He did not attempt to institute a direct comparison of the recorded radiation temperatures with the number of the sun's spots, a proceeding which would probably have failed to lead to any definite result in English latitudes and in so cloudy a climate; but took as the first term of his comparison the ratio existing between the excess of the maximum radiation over the maximum air-temperature in the shade, and that of the mean air-temperature over that of the wet bulb, or the dew point deduced therefrom. His conclusion was to the effect that the sun's heat undergoes a distinct periodical variation, coinciding with and directly as that of the spots.

* Zeitschrift der Oesterr. Gesellschaft für Meteorologie. Vol. viii. Nos. 16 and 17.

† It is to be noticed as a remarkable fact that Prof Köppen finds the epochs of maximum and minimum temperature to correspond (not as might be expected from the results of the present investigation with the maxima and minima of sun-spots respectively), but approximately with the opposite phases; the *maximum* of temperature (in the tropics) preceding the *minimum* of the sun-spots by 0·9 of a year, and the minimum of the former the maximum of the latter by 0·1 year.

It is evident that India offers far greater advantages for investigating the variations of the solar heat than any European country can do, and as observations of the black-bulb thermometer *in vacuo* have now been registered at several stations during the last six or seven years, I have lately examined a portion of these, to see if they afford any direct evidence of a periodical graduated variation in the intensity of the radiation. The result is to me very striking, and if not absolutely conclusive as to the direct variation of the sun's heat with the number of the spots and prominences, certainly, as far as it goes, strongly confirms Mr. Baxendell's conclusions, drawn from indirect evidence.

It is unfortunate that owing to the fragility of the instruments employed and the necessity of exposing them freely, they are very frequently broken; and, as a consequence, the longest series of observations made with one and the same instrument extends over only five years. This is at Silchar in Eastern Bengal. The place is situated in lat. 25°, therefore beyond the tropic; and the climate being very damp and more cloudy than most parts of Bengal, it is not, perhaps, so favourably circumstanced for the present purpose as some other stations.

The means of the maximum sun-temperatures registered on clear days (that is, on days when the proportion of clear sky estimated at 10 A.M. and 4 P.M. did not average less than three-fifths) are given in the following table. The months of the S.W. monsoon are omitted, since in some cases they do not furnish a single clear day according to the above definition, and as a rule such days are too rare to contribute much evidence of value. I give for each month the number of clear days that have contributed to the mean.

TABLE I.—*Average maximum temperature of solar radiation on clear days at Silchar.*

	Days.	1870	Days.	1871	Days.	1872	Days.	1873	Days.	1874
January . .	24	124·8	25	127·1	27	122	21	121	19	121
February .	19	130·4	20	130·9	20	125·8	19	128·2	8	128·2
March . .	15	137·2	19	135·7	23	133·8	17	132·4	10	134·3
April . . .	12	142·6	17	139·1	13	140·5	12	134·5	5	139·8
May . . .	10	144·7	15	142·8	14	143·8	5	140·6	6	146·5
October . .	16	140·7	19	136·7	9	141·3	7	140	5	146·4
November .	23	132·2	27	126·3	15	131·7	20	127·7	10	143·1
December .	29	124·7	25	121·3	18	121·5	23	121·2	14	136·7
Year . .	148	134·6	167	132·5	139	132·5	124	130·7	77	137

Did this table stand alone, the evidence of any periodical variation would be very doubtful. But we shall presently see that the irregularities that it exhibits are all but completely neutralised by the registers of other stations. It is easy to suggest their explanation, grounded on the fact to which all the registers testify, that the highest sun-temperatures occur, not on days registered as cloudless, but on those on which there is a considerable proportion of cloud, and frequently rain. Such days were numerous in 1874; while in 1871 (the year of sun-spot maximum) days without visible cloud predominated. Leaving the discussion of this question, however, as unnecessary in this place, I will give the combined results of Silchar and eight other Observatories variously situated, some in, and others beyond the tropical zone. These are:—

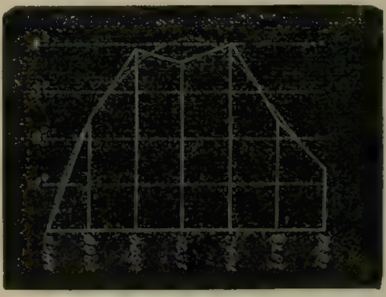
Port Blair, in the Andamans	lat. 11°	41′	N.
Cuttack, in Orissa	„ 20	29	„
Chittagong, on the Arakan coast ...	„ 21	39	„
Jessore, on the Gangetic delta ...	„ 23	9	„
Dacca, also on the delta	„ 23	43	„
Hazaribagh,* elev. 2,000 ft. in Western Bengal	„ 24	0	„
Berhampore,* on the Gangetic delta ...	„ 24	6	„
Roorkee, elev. 900 ft. in the N.W. Prov.	„ 29	52	„

Since the radiation-thermometers originally in use at most of these stations have been broken and replaced by other instruments, and since these thermometers (furnished by the best London makers) sometimes differ to the extent of many degrees when placed under the same conditions of exposure, it would be only misleading to compare together the registers of different years recorded with different instruments at the same station. In order to avoid this source of error, and at the same time to bring in evidence as much as possible of the registers, I have taken for each station separately the difference (rise or fall indicated respectively by + and −) of each pair of homonymous months in consecutive years, omitting all cases in which the instrument has been changed in the interval; and then the mean of all the differences thus obtained for the same pair of months. The results are given in the following table, additional columns being added to show how many stations have contributed to the mean of each pair of months. As in Table I., the mean temperatures compared are those of clear days only; but with the exception of Port Blair, I have admitted as clear days those only on which at least four-fifths of the sky on an average was estimated as unclouded at 10 A.M. and 4 P.M. In the case of Port Blair it was necessary to admit days with only one half of unclouded sky.*

TABLE II.—*Annual variation of mean maximum readings of black-bulb thermometers on clear days.*

	Station.	1868 1869	Station.	1869 1870	Station.	1870 1871	Station.	1871 1872	Station.	1872 1873	Station.	1873 1874
January . .	2	− 0·9	3	+ 0·5	4	+ 0·4	6	− 3·7	4	+ 0·4	8	− 5·3
February .	2	+ 1·9	3	− 1·5	4	+ 0·6	6	− 3·6	4	+ 2·1	8	− 3·6
March . .	2	+ 3·8	3	+ 1·2	4	+ 2·6	6	− 2·4	5	− 0·7	8	− 1·7
April . . .	[illegible]	+ 7·1	3	+ 1·5	7	− 0·5	5	+ 0·7	6	− 2·6	8	0·2
May . . .	1	+ 14·2	3	+ 0·9	7	− 1·9	4	+ 2·6	7	− 0·7	8	− 2·5
October . .	2	− 4·3	3	+ 8·2	6	− 1·5	4	+ 4·0	8	− 4·7	8	+ 2·7
November .	3	− 2·7	4	+ 0·4	6	− 0·6	4	+ 3·5	8	− 3·6	8	+ 0·8
December .	3	− 1·0	4	+ 1·8	6	− 1·3	4	+ 2·2	8	− 2·9	8	+ 0·9
Year . .		+ 2·3		+ 1·6		− 0·3		+ 0·4		− 1·6		− 1·1

If these differences be plotted as the increments of a series of ordinates, and the curve thus marked out be corrected for its small irregularities *liberâ manu*, its resemblance in general character to the sun-spot curve will be distinctly apparent. (See figure.)



I have been unable to ascertain (here in Calcutta) the number of spots observed during the last few years; but this datum can readily be supplied at home.

Calcutta, May 28 HENRY F. BLANFORD

LECTURES AT THE ZOOLOGICAL GARDENS†

VIII.

Mr. Sclater on the Pheasants.

IN that Birds possess a high temperature of the blood, they agree more with the mammalian than with other vertebrated animals; the balance of anatomical evidence is, however, in favour of their more intimate reptilian affinities. They are characterised externally by their covering of feathers, and by the fore limbs being developed to form wings. These wings, though primarily constructed for flight, in some birds perform other functions. In the Penguins they are employed for swimming, in the Ostrich to assist in running, whilst in the Apteryx and the Cassowary their condition is so rudimentary that they can be of no service to their owners. In the Night Parrot and the Weka Rails the wings are very much diminished.

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* The registers of these two stations taken alone give a curve nearly approximating to the resultant of all the stations, but it is of doubtful validity owing to the thermometers having been twice renewed at both stations.

* I have ascertained by direct comparison that any difference thus introduced is inappreciable, the results being treated comparatively, and not for absolute values.

† Continued from p. 130.

Birds are divided into from seventeen to twenty well-marked groups, of which the Gallinæ, the order which contains the Pheasants, forms one which is more important in an economical point of view than any of the others, as it contains most of the domesticated species of birds, the ducks and pigeons being exceptions. The Game Birds, as the Gallinæ are commonly termed, may be divided into the following seven sections:—1. The *Pteroclidæ*, or Sand Grouse, birds which inhabit Africa and Western Asia. By some naturalists they are grouped with the Pigeons; they, however, differ from them and agree with the fowls in laying coloured eggs, at the same time that the young ones run about directly they are hatched. There is one species, found in the steppes of Tartary, in which, unlike its allies, the hind toe is absent. In the year 1863 a flock of Sand Grouse spread over all Western Europe. Prof. Newton tell us, in the "Ibis," that not less than seven hundred individuals must have appeared. A few stragglers were seen for a short time afterwards. 2. The *Meleagridæ*, or Turkeys, are unfortunately so called, as they are in their wild state confined to Northern and Central America. Only three wild species are known, the most northern of which is said to be the parent stock of our domesticated form, although some of the evidence is in favour of the latter having sprung from the Mexican species. The Ocellated Turkey, from Honduras, is a particularly handsome bird. 3. The *Numididæ*, or Guinea Fowl, are represented in Guinea by one species. The four or five others are all confined to Africa; of these, the elegant Vulturine Guinea Fowl, of which several specimens have been presented to the Zoölogical Gardens by Dr. Kirk, comes from Zanzibar. 4. The *Cracidæ*, or Curassows, are the representatives of the Game Birds in Central and South America. They will not nest in captivity here, perhaps because, as they are arboreal in their habits, it is not possible to give them suitable abodes. They are said to have been first introduced into Europe by the Dutch, from the island of Curassow, in the West Indies. In some species the cock and hen are identical in plumage; in others very dissimilar. 5. The *Megapodidæ*, or Megapodes, are confined almost entirely to the Australian region. They are nearly allied to the Cracidæ. Their eggs are laid in the middle of a mound composed of earth and grass, where they are left to be hatched. Many eggs are laid, and the young ones are able to fly within twenty-four hours of leaving the egg. Their breeding habits have been well described by Mr. Bartlett, from examples which have laid in the Society's Gardens. By one species the mound constructed is as much as 15 ft. high and 60 ft. in circumference. The habits of one peculiar species, the Maleo of Northern Celebes, have been well described by Mr. Wallace. 6. The *Turnicidæ*, or Hemipodes, much resemble quails. They are mostly African, one species occurring in Andalusia. Their anatomy is somewhat peculiar. 7. The *Phasianidæ*, or Pheasants, are constituted by (*a*) the *Tetraonidæ*, or Grouse, inhabitants of the mountainous regions of Europe and Northern Asia. In all the species the legs, and in some the toes, are feathered. They do badly in captivity. The best known of them are the Prairie Fowl, Capercailzie, Black-cock, and Ptarmigan. (*b*) The *Perdicidæ*, or Partridges, are found in every part of the Old World. The Snow Pheasant of the Himalayas is one of the largest species. The Impeyan Pheasant, from the same locality, is a closely allied form. These birds are represented in America by (*c*) the *Odontophoridæ*, or Colins, sometimes called toothed Partridges, because the bill is slightly toothed. They are much more arboreal than their Old World representatives, and none of them attain a great size. (*d*) The *Phasianidæ*, or Pheasants proper, form about forty species, arranged in seven genera. The story runs that the common Pheasant was first brought from Colchis by the Argonaut, whence its scientific name, *P. colchicus*. The genera include the *Crossoptilons*, or Eared Pheasants of Northern Asia, of which there are four species: the true Pheasant, preserved in this country; the *Thaumalea*, or Gold Pheasant, with its superb ally, the Amherst Pheasant of Central Asia, first made known from a specimen brought over by the Lady Amherst when returning from an embassy to the King of Ava. Further facts respecting its distribution have been obtained by Dr. John Anderson and Mr. Stone. The *Euplocami*, or Kaleeges, are represented by twelve species. They are intermediate between the Pheasants and the Fowls. A new species has been quite recently obtained by Mr. Gould from the interior of Borneo (*Lobiophasis*). *Gallus* is the name given to the genus which includes the Fowls, of which there are four species. The Jungle Cock of India is the wild ancestor of the domesticated bird; others are inhabitants of Ceylon and Java. *Ceriornis* includes the Tragopans, which are peculiar in having horned appendages to the head. There are five species in this beautiful group. (*e*) The *Pavonidæ*, or Peafowls, are natives of the forest jungles of India, and such being the case it is strange that they so well resist the winters of our own country. *Polyplectron*, or the Peacock Pheasant, is an allied form; it is aberrant, however, in that it is monogamous and lays only two eggs. The Argus Pheasant also belongs to the same family.

THE PROGRESS OF THE TELEGRAPH *

VIII.

MORE daring inventors, as we have seen, entered the field—Nott and Gamble, with a letter-showing telegraph; Edward and Henry Highton, who produced an array of signal apparatus, in some cases evading the Cooke and Wheatstone patents by the use of nickel for the electro-magnet in place of soft iron. But formidable beyond all other competitors was the talented Alexander Bain, the Edinburgh watchmaker, who has contributed largely to the improvement of the telegraph by his singularly beautiful adaptations and chemical printing arrangements. Expensive litigation speedily followed, and the directors in most cases compounded with their opponents. Alexander Bain was made a director of the Company, and at the same time received 12,000*l.* for his chemical printer, and most of the other opposing patents became the property of the Company by special arrangements with the inventors. By means such as these a monopoly for a time was secured, even though it was purchased at an exorbitant price. Monopoly at that time represented commercial gain, and every aspiring inventor was sooner or later run off his feet by the powerful and wealthy corporation. Such is the early history of the introduction and opening of the Electric Telegraph as a means of the transmission of inland intelligence. The telegraphic connection of Great Britain with the Continent of Europe at this time was scarcely developed, the extent of electrical communication by the continental land lines being circumscribed.

This, however, thanks to further applications of science, is no longer the case. The planet is now girt by telegraphs. First, there is the "Great Northern," stretching from London, the telegraphic centre of the world, by land and submarine circuits into Denmark, Norway, Sweden, and Russia in Europe, thence across the wilds of Siberia in Asiatic Russia to the Japanese Sea, and on to Japan, terminating within the tropics, at Hong Kong. Secondly, the "Eastern Telegraph," which, crossing the Bay of Biscay, reaches Lisbon, and thence threading its way under the dark blue waters of the Mediterranean Sea to Suez, reaches India by the Red Sea and Indian Ocean, and on to Ceylon (Point du Galle), joining the "Great Northern" at Hong Kong *viâ* Singapore. Thus by means of these two great systems a complete circuit of the continents of Europe and Asia is effected, the one within the limits of the tropics, the other bordering upon the Arctic circle, reaching as it does to 62° of north latitude. At Singapore the circuit is divided, a branch extending south to Sumatra, Java, and the continent of Australia,—Sydney, Melbourne, and Adelaide being reached; New Zealand being about to be included. Thirdly, there is the vast stretch of the South Atlantic Ocean traversed by the circuits of the "Brazilian Submarine," connecting Great Britain, *viâ* Lisbon, with Madeira, St. Vincent, and the continent of South America to Pernambuco. There it joins the coast submarine circuits of the "Western and Brazilian," extending north to Para and south to Bahia, Rio Janeiro, Rio Grand do Sul, and Monte Video in the River Plate, at which station, in connection with the local lines of the River Plate Company, it reaches Buenos Ayres, thence by means of the wires of the Argentine Republic, crosses the Andes into Chili and Peru. From Para the electric circuit is extended (Para and Demerara being now under completion), by way of the West India Isles, Jamaica, and Cuba, to Florida, there joining the extensive system of the United States Trunk lines; to San Francisco, west, and Newfoundland, east; and thence, by the circuits of the "Anglo-American" and "Direct United States" cable, crossing the Atlantic Ocean to Great Britain. Thus the New World is also encircled by two great systems, the one almost equatorial, the other within the higher degrees of northern latitude.

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* Continued from p. 113.

In dealing with submarine circuits the electrician has several matters to consider and accurately adjust, some of which will be more fully considered hereafter. First, there is the copper-conducting wire, its capacity according to the length of the circuit. Too small a conducting wire on a circuit of a given length would offer too great a resistance; too large a conducting wire would be equally faulty, induction increasing in greater proportion from its large superficial surface than its increased sectional area augments the speed. The exact sectional area of the wire has therefore to be determined; then for insulation, the best relative proportion in weight, and sectional measurement between the wire and that of the insulating material. Insulation, as is well known, may be obtained by a mere film of a non-conductor surrounding the wire. This is illustrated by the simple experiment of passing a weak voltaic current of electricity through an extended fine metallic wire immersed in a trough of water. Under ordinary circumstances it is but natural to suppose (water being a conductor) that there would be no insulation; not so; by the action of the current through the wire decomposing the water, a fine non-conducting film of hydrogen is developed surrounding the wire, which, with a strength of current adjusted to the resistance of the wire, will separate the water from the metallic conductor, perfect insulation being maintained. Destroy the balance between the current and the wire, and the hydrogen, evolved too rapidly by reason of electrical decomposition, accumulates upon the surface of the wire and, passing off in the form of small bubbles, destroys the insulation. This simple experiment demonstrates that insulation in the abstract sense may be obtained by a very thin covering of a non-conductor. It is, however, in practice mechanically unsafe to rely upon mere tissues of insulating material surrounding the conducting wire; a certain thickness is absolutely necessary for security. Every insulated core to be used for submarine purposes, to ensure integrity of manufacture, should be tested under pressure, so as to break down all mechanical imperfections in the coating of the insulating medium, before the cable is submerged. The determination of the dimensions of the insulator influences also materially the inductive effect of the circuit; and when it is remembered that the best insulating material represents a cost of about 6*s.* per pound weight upon the wire, the close connection between science and pounds shillings and pence becomes at once apparent. The variations in weight per nautical mile of copper and insulation in some of the recent important cables are here given. The Atlantic main cables of 1865 and 1866: copper 300 lbs., insulation 400 lbs.; lengths each about 1,900 nautical miles. French Atlantic main cable, 1869: copper 400 lbs., insulation 400 lbs.; length about 2,600 nautical miles. Falmouth and Lisbon, 1870: copper 120 lbs., insulation 175 lbs.; length about 800 nautical miles. Anglo-Danish Cable, 1868: copper 180 lbs., insulation 180 lbs.; length, 365 nautical miles. Hong-Kong—Shanghai, 1870: copper 300 lbs., insulation 200 lbs.; length, 1,100 nautical miles. China Telegraph, 1870: copper 107 lbs., insulation 140 lbs.; length, 1,632 nautical miles. British India Extension, 1870: copper 120 lbs., insulation 175 lbs.; length, 1,448 nautical miles. Eight important submarine circuits have here been summarised, and in six it will be found that the proportions in the weight per nautical mile between the copper and insula-

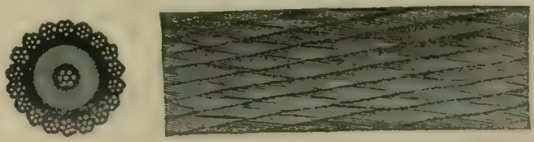
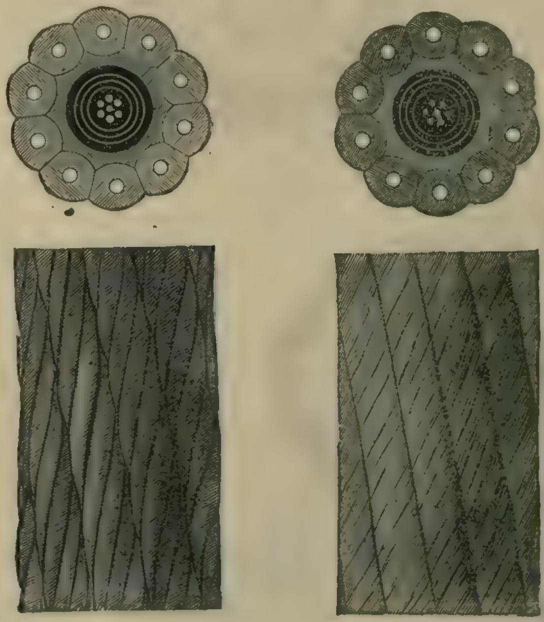


FIG. 34.—First Atlantic Cable, 1857 (natural size).



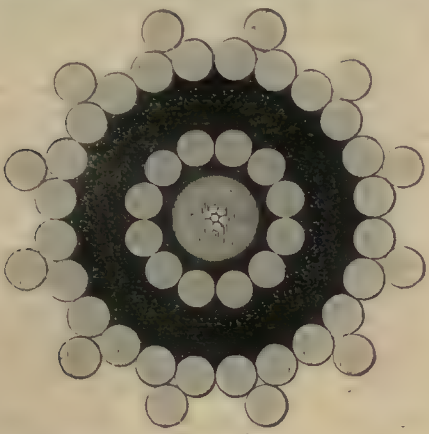
1865. 1866.

FIG. 35.—Atlantic Cables laid in 1865 and 1866, between Valentia and Newfoundland (natural size), weight per naut. 1·75 tons.

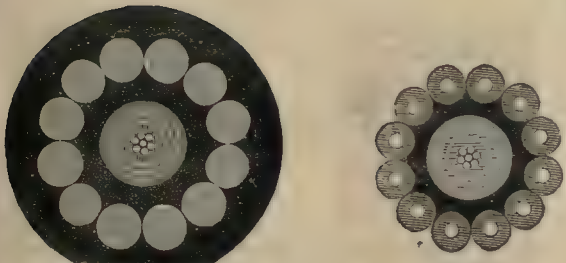
tion vary in an extreme degree. Thus there is found copper and insulation in the respective proportions by weight of 1 to 1, also 3 to 4, also 3 to 2, also 2 to 3, and also in the irregular proportion of 11 to 14. By these figures it appears that there is no accepted ratio, and every new cable seems to be constructed according to the electrical views of the designer, in some cases at an enormous cost, as compared with others of similar length and equal efficiency in transmitting power. Thus, by reducing the weight of material per nautical mile into an average money value, assuming for copper 1*s*. 2*d*. per lb., and insulation 6*s*. per lb., we obtain the following ratios :—

1,100 nautical miles :	copper	£16	0	insulation	£60
1,632	,,	,,	6	5	,,	42
2,600	,,	,,	23	10	,,	70
2,000	,,	,,	16	0	,,	70

With such indiscriminate specifications there is certainly something left to discover, and the next few years may determine with some degree of accuracy the true proportions by weight to be adopted between the conducting wire and the external thickness of the insulator, to obtain the best practical results at the least expenditure of capital on a circuit of given length, worked with one of the sensitive recording instruments already brought under notice. As an example of the augmentation of speed upon a submarine circuit, according to the delicacy of the recording instrument employed, upon the Great Northern cable between England and Denmark, 365 nautical miles in length, with the most improved submarine morse, an average of seventeen words per minute was obtained; with the Wheatstone's automatic thirty words, and with the Thompson syphon recorder fifty words per minute are practically reached.



Shore end.



Intermediate. Main.

FIG. 36.—French Atlantic Cable laid between Brest and Island of Saint-Pierre, 1869.

For many years there has existed a divided opinion as to whether a light submarine cable, combining economy of construction with mechanical facilities of laying, is not the right system to adopt as against the heavy and more expensive form of iron covered cable. The light cable theory may be said to be based upon the opinion of the late Lieut. M. F. Maury, who through every opposition adhered in principle to light cables. His argument may be expressed in his own words: "You may snap a taut rope, but you cannot break a slack line." This remark may nautically be quite true, but electrically far from correct, for the following reasons. In submerged cables, speed is greatest upon the shortest line. Now, in deep-sea telegraphy, in the only circuits upon which a light cable could possibly be employed with any security against mechanical interruptions, two or three points come into play. Supposing a light cable were to be used over, say, a circuit of 2,000 miles, with an average depth of 1,500 fathoms, or about 1¾ miles. First, take the specific gravity of the light cable as compared with water, at what rate will it sink to the bottom? if not so adjusted as to sink at about one mile per hour (looking to the enormous sweep between the paying out steamer and the bottom of the ocean at the depth of 1¾ miles), it is more than probable that although you cannot break a "slack line," it may be so twisted and contorted by surface-currents and under-currents moving at various velocities or even in opposite directions as it slowly sinks to the bottom by reason of low specific gravity, that a very great length of cable may be paid out (as a slack line). Secondly, the cost of this increased mileage must be taken into account as compared with that of the heavier iron-sheathed cable upon which a mechanical strain can be placed to ensure more or less a "Bee" line. Thirdly, the speed of transmission through a submarine cable is inversely as the square of the length. Now, if this is practically correct, it is easy to determine whether the best commercial results will be obtained from a light cable with increased electrical resistance, although it may be carried out at a less original outlay, or from a shorter cable more costly per mile from increased strength and weight of iron, but with greater transmitting speed, and in consequence dividend earning capacity. But of equal importance with any of the previous points is the impossibility of grappling a light cable from any considerable depth in cases of injury affecting the insulation. To raise a cable from a depth of 1¾ miles involves a great strain upon the cable, and unless the breaking strain has been calculated to meet such an emergency, any successful attempt at restoration must be abandoned, and the entire line is rendered useless and the capital lost. Every submarine cable should be laid with a certain percentage of slack, regulated according to depth of water and surrounding circumstance. The average slack is from 8 to 14 per cent.

The first Atlantic cable, 1857, between Valentia and Newfoundland, is shown in elevation and section at Fig. 34. This cable, from imperfect construction, remained electrically sound for a very limited period, and very few messages were successfully passed through the conducting wire. It, however, became the pioneer to success, and elucidated several important points in connection with the design of the 1865 and 1866 Atlantic cables shown at Fig. 35. The covering of these cables consists of ten strands of Manilla hemp, each containing a homogeneous steel wire. The French Atlantic iron-sheathed cable between Brest and Saint-Pierre, laid in 1869, is shown at Fig. 36.

			Tons.
The weight of the main cable per naut is		...	1·652
,,	intermediate ,,	...	6·246
,,	shore ends ,,	...	20·447

(*To be continued.*)

SCIENCE IN GERMANY

(*From a German Correspondent.*)

SINCE Darwin first gave the signal for a complete rupture with the old tradition of the morphology of animals, Germany has zealously continued working in the new direction, trying to bring anatomical, embryological, and biological facts into causal connection with each other by the comparative method. Darwin's theory remains the basis, and it has been principally Haeckel who, in advance of all its supporters, deduced further important consequences; the antagonists of the theory have confined themselves to a purely negative criticism. At one time the whole theory with all its suppositions and deductions was rejected by them; at another, the theory of descent was accepted in principle, but the further representation of its connection with the anatomy and the development history of animals was refuted; in all cases they either returned to the old views openly or they were satisfied with simple contradiction, leaving it to the future to fill up the gaps thus produced in the theory. In a work that has lately been published, the attempt has been made to consider the whole science of the morphology of animals from a different point of view. This work is: "Die Entwicklungsgeschichte der Unke als Grundlage einer vergleichenden Morphologie der Wirbelthiere" (the History of Development of *Bombinator igneus* as the basis of a Comparative Morphology of Vertebrata), by Dr. Alexander Götte, Professor of the University of Strassburg.

From a careful examination of the individual history of the development of Vertebrata and comparative consideration of the lower types, Götte tries to determine the morphological laws for the individual species, and from this to deduce their causal connection; he thus arrives at certain general theorems which, according to his view, form the basis for a conception of the origin of new animal species, totally different from Darwin's view. On the one side Götte does not look upon the animal ovum as a cell, nor in fact as a living organism at all; this of course is different from all other theories hitherto published. According to his view the cells, which are the basis of the formation of the ovum, only produce a conglomeration of a certain material (yolk) in a certain arrangement, but are themselves dissolved sooner or later, so that the complete ovum is a peculiar body, not living, but endowed with properties that enable it to be converted into a living organism under certain conditions. He maintains that this capacity for development is not the simple consequence of the chemical composition of the yolk, but that it only contains the motive force which is freed by chemical processes, and can do very different work according to the physical conditions under which it happens to be. The result may therefore as likely be the destruction of the ovum as its further development. For the latter, perfectly certain conditions of form are necessary, which have already been initiated during the formation of the ovum, and cause the force in question to work in a direction just as determined and certain as they are themselves. The results in that case are self-divisions of the yolk, when the parts are either of equal or of different sizes, and produced at different intervals. The former separate very soon and form separate individuals, which therefore consist only of one element and represent the lowest type (Protozoa); the ova of Matazoa, which are unequally divided according to a certain law, remain whole. Their coarser formation is brought about in a purely mechanical way, each division causing a displacement.

Thus Dr. Götte finds the basis of the fundamental structure, the type of each animal species, in the differences originating through the laws regulating the first divisions of the yolk.

NOTES

AN Exhibition of 50*l.* a year, tenable for four years, was recently devoted by the Endowed Schools Commission for annual competition between the four schools of Taunton, Tiverton, Exeter, and Sherborne. The details of the competition were left entirely to local trustees, whose names we do not know, but whom we understand to be gentlemen of the county of Somerset. The regulations issued by the trustees are before us. They very properly order that the examination shall be conducted by the Oxford and Cambridge Schools Examination Board. The subjects proposed by that Board include four groups, of which Science is one, and all candidates, whether choosing to take up Science or not, are permitted, if they please, to substitute Botany for Latin Verse, and Physical Geography for Greek Prose Composition. The scheme of the Somersetshire trustees includes all the subjects named by the Universities *except those which come under the head of Science*, refusing to permit any branch of science to form part of the examination, whether as an independent topic or as an alternative. We content ourselves for the present with the statement of a fact likely to interest all our readers, those more especially who are aware of the efforts that have been made during the past six years to establish in the county of Somerset a centre of first-rate scientific teaching.

AMONG the additional estimates recently voted by the House of Commons is one for the salary of an Assistant-Director to the Royal Gardens at Kew. Everyone will be rejoiced to hear that the arduous duties of the Director are likely to be lightened by this appointment, which has been filled up by the selection of Prof. Thiselton Dyer.

IN connection with the Commission appointed by the President of the United States to experiment and report upon the metals used in construction (NATURE, vol. xii. p. 94), Mr. R. H. Thurston, the Secretary, has issued circulars expressing his desire to secure the assistance of all who are interested in this great work, and through them to obtain all information available as the result of the labours of earlier or of contemporaneous investigators and observers. The circulars indicate the scope of the labours undertaken by this Commission, and request aid from all in a position to render it, in the collection of all information which may be accessible, relating to either the general work of the Commission or to the special subjects assigned to its committees. Data collected in the course of ordinary business practice, and the records of special researches previously made or now in progress, are particularly desired. It is expected that the Commission will receive valuable information and useful suggestions, both from business men and from men of science, and it is hoped that the work undertaken by the Commission may be supplemented by original investigations made by both these classes. The great importance of this work justifies the expectation of an earnest and effective co-operation. Part of the work of the Commission is the investigation of the methods and effects of Abrasion and Wear of metals in engineering and mechanical operations. Valuable data for the purpose could be furnished by railway engineers and others in regard to the wear of rails, wheels, axles, journals under heavy loads or at high velocities, the wear of tools, and other points, and we hope that all in this country who have it in their power will lend what aid they can to this important Commission. Another part of the Commission's work is a series of determinations of the effects of carbon, phosphorus, silica, manganese, and other elements, upon the strength, toughness, elasticity, and other qualities of iron and steel. Mr. A. L. Holley, Chairman of the Committee on Chemical Research, issues a circular giving detailed instructions as to the specimens and kind of information wanted. We should advise all interested to apply to Mr. R. H. Thurston, Stevens Institute of Technology, Hoboken, N.J., for detailed information; and we think the

Board would do well in sending circulars to the engineers of our principal railways, as well as to all others who are likely to be able to give them help in their laudable and valuable work.

WE are informed that H.M.S. *Challenger* will have completed her cruise and be back in this country by April of next year.

THE library of Audubon, the ornithologist, was destroyed by fire in April last. It was in the house of Mrs. Bakewell, the sister-in-law of Audubon, at Shelbyville, Ky.

THE twenty-fourth annual meeting of the American Association for the Advancement of Learning will be held in Detroit, Mich., beginning on Wednesday, August 11 next, under the presidentship of Mr. J. E. Hilgard, of Washington.

DR. HORNER, the medical officer on board the *Pandora*, which left England yesterday for the Arctic seas, will take upon himself all the meteorological duties of the expedition. Lieut. Banyan, of the Dutch navy, will act as scientific officer, it being intended that botanical and marine research will form a prominent duty of the expedition. Hall's Esquimaux Joe also accompanies the expedition, and altogether there are thirty-two souls on board. Capt. Allen Young hopes to get as far north as Carey Island, at the entrance of Smith's Sound. On this island a "post-office" or cairn has existed for many years, and, accordingly, all the letters Capt. Allen Young takes with him for the *Alert* and *Discovery* will be deposited here, unless he falls in with one of those vessels. The commander of this new expedition will push to the north-west after leaving Carey Island, and if the *Pandora* succeeds in forcing a way through the north-west passage, as Capt. Allen Young hopes, she will be the first steamship to accomplish the marvellous feat. She may possibly return in November next.

IN Part X. of the *Deutsche Rundschau* there is an excellent review of Capt. Lawson's wonderful book, "Wanderings in the Interior of New Guinea" (which we noticed in our issue of the 3rd inst., vol. xii. p. 83). The review is by Prof. A. B. Meyer, director of the Zoological Museum at Dresden. Like every sensible man, Prof. Meyer points out the absurdities with which this book is crammed. Indeed, he owns that he was almost of opinion that it was the author's intention to write a satire on modern narratives of travel, and that on the last page of the book the reader would be told of this; "but, unfortunately, Capt. Lawson is constantly in earnest; indeed, he left no stone unturned to make the book attractive, and to pass off its contents as real facts." Prof. Meyer dwells at some length on Capt. Lawson's marvellous mountain ascents, on his wonderful hunting feats, and his most surprising discoveries in the animal and vegetable world. He points out that with regard to the quadruped fauna it is well known that tigers are not found further eastward than Java, monkeys not further than Timor, and deer not further than Halmahera, and that it is incredible that these species, besides buffaloes, foxes, and hares, exist in New Guinea. Prof. Meyer, in conclusion, thinks it rather surprising that shortly after the publication of this wonderful book of fiction a deputation led by the Duke of Manchester should have waited upon the Colonial Secretary with a view to induce the Government to annex New Guinea. He asks, "Was this a consequence of the marvellous description of the distant country, or has the sensation novel been manufactured to order?"

A NEW steering balloon by Smitter is being exhibited, suspended in the middle of the Alcazar in Paris. The measurement is only 6,000 cubic feet, but the balloon is so light, that when filled with pure hydrogen it must float. A considerable sum of money has been invested in it, and great ability has been displayed in the construction. Although no practicable result in open air may be hoped for, it is a wonderful piece of clockwork. In connection with this subject it is stated that for several months past a firm of engineers have been experimenting privately at the Crystal Palace with an aërial steamer of a novel and promising character, weighing 160 lbs. Experiments are stated to have proved the capability of two vertical screws, each 12 feet diameter, to raise a weight of 120 lbs.; the steam-engine, with water and fuel, forming part of the weight so raised to the extent of 80 lbs. The power exerted by it is equal to two-and-a-half horses. The communication of motion is given by a vertical axis emanating from the car.

AT a Congregation held on Friday, the report of the Cambridge Syndicate recommending the purchase by the University of the collection of models, instruments, and tools used by the late Prof. Willis was confirmed.

CAPT. R. F. BURTON writes to the *Times* stating that the Italian African Expedition, under the Marchese Antinori, is reported to have for its ultimate object the wholly unvisited section to the south-west of Christian Abyssinia and the Abai River, "connecting known countries with the so-called Victoria Nyanza Lake."

WE regret to announce the death of M. Le Besgue, oldest Correspondent to the Geometry Section of the Paris Academy of Sciences. He died on June 12, at Bordeaux.

ON Tuesday a deputation from the Highland and Agricultural Society of Scotland waited upon the First Commissioner of Works, to ask the Government to proceed with the Survey of Scotland, which had been for some years in abeyance, and also to allow it to be done on a 25-inch scale of maps. A memorial was handed in to show that the opinion of the Scotch people was that the Survey should be at once carried out. Lord Henry Lennox promised to give the subject his best consideration, and remarked that the applications for the same object from different parts of the United Kingdom made it difficult to obtain from the Treasury any grants for the purpose.

AN important Report of a Committee of Council appointed to consider the requirements of Oxford University, as amended and adopted by Council, has been circulated for the information of members of Convocation. The "Requirements of the University" may be conveniently divided into Provision for Buildings and Institutions, and Provision for Professors and Teachers. Under the head of Buildings and Institutions, it is stated that with reference to the Botanic Garden, if it is to remain where it is, the lease being renewed, considerable amount of reconstruction is required, estimated at 4,000*l*. If it is to be removed to the Parks, a much larger outlay will be required. With regard to the University Museum, the heads of the three chief departments (Chemistry, Biology, Physics) report that additional buildings are required in each of the three, roughly estimated in all at 30,000*l*. Under the head of Provision for Professors and Teachers, the Committee find many demands which it is difficult to meet at once; one of their principal suggestions is the appointment of a Board for the following purposes:—1. To appoint lecturers from time to time to deliver lectures in the University on any subject that may seem to the Board to claim attention, and to assign payment to such lecturers. 2. To make occasional grants to individuals for the purpose of carrying on special work in connection with the studies or institutions of the University. 3. To appoint Readers for limited periods, not exceeding ten years, in subjects in which public teaching within the University may seem to the Board to be desirable; and to assign the stipends to such Readers; such appointments and the stipends being subject to the approval of Convocation. The

Board also, under certain conditions, might be entrusted with the duty of appointing Professors for life. It appears, however, that several additions to the permanent staff of Professors will be required. These must be provided for, the Report states, from time to time, by statute. Thus, for example, the following suggestions have been made with regard to the chief departments of study pursued in the Museum:—1. In the department of Chemistry it is stated that an additional professorship is required. 2. In the department of Physics also it is stated that an additional professorship is required. 3. In the department of Biology it is proposed—(*a*) That the present Linacre Professorship should become a Professorship of Human Anatomy and Ethnology. (*b*) That the Hope Professorship of Zoology should become a Professorship of Zoology and Comparative Anatomy. (*c*) That the Clinical Professorship of Medicine should become a Professorship of Physiology and Public Health.

A CORRESPONDENT sends us the enclosed cutting from *Le Français* as an illustration of how they do things in France:—"On sait que sur la proposition de M. de Cumont, ministre de l'instruction publique, des cultes et des beaux-arts, l'Assemblée a voté, le 18 juillet dernier, une pension annuelle et viagère de 12,000 fr. à M. Pasteur, membre de l'Institut, professeur à la Faculté des sciences de Paris, à titre de récompense nationale. Un nouveau décret, rendu par M. le maréchal de Mac-Mahon sur le rapport de M. Wallon, contre-signé par M. Leon Say, vient d'accorder une nouvelle pension de 6,000 fr. à M. Pasteur, indépendamment de celle de 12,000 fr. qui lui avait été donnée précédemment. De telles mesures ne peuvent qu'encourager nos hommes de science et stimuler l'esprit de découverte. Cette pension permettra donc d'assurer d'une manière digne de lui les jours d'un homme qui compte près de trente-trois années de services dévoués, et que les fatigues d'un travail assidu ont mis dans l'impossibilité de continuer à exercer ses fonctions de professeur."

LAST Thursday, in the House of Commons, in reply to a question by Sir John Lubbock, the Chancellor of the Exchequer said he would be ready to consult with his colleagues in the course of the autumn to see whether the object of preserving the ancient monuments of the country could in any way be carried out. Sir J. Lubbock, considering this a favourable answer, said he would withdraw his Ancient Monuments Bill.

A SPECIMEN of a sturgeon, eight feet in length, has been added to the Manchester Aquarium. Several examples of the Wolf, or Cat Fish, and three of the Monk, or Angel Fish, each five feet long, are also to be seen in the same building.

DURING this season the *Morning Post* has made a speciality of noticing the proceedings of some of the learned societies. The lectures at the Royal Institution have generally occupied half a column, and some of the popular lectures of the Zoological Society have been given at equal length. In a notice of one of the ladies' lectures of Prof. Bentley at the Botanic Society is this passage:—"Future historians of the social condition of the people of England at our period will have to make constant reference to the daily press, and it is therefore but right, alongside of the notices of the culture of music and the sister fine arts, to record each attempt to spread the knowledge acquired by men of science." We are glad the *Morning Post* has set so good an example.

PROF. NORDENSKJÖLD'S expedition left Tromsö for Novaya Zemlya on June 8. The expedition is undertaken on board the Norwegian Arctic sea-yacht *Pröven*, Capt. J. N. Isaksen, who has been to Spitzbergen and Novaya Zemlya a great many times previously. On the southern coast of the latter island the party expect to meet with Samoyedes; they intend then to move in an easterly direction, towards the rivers Obi and Yenesei. Prof. Nordenskjöld will then leave the ship to continue the expedition by boat.

THE so-called tobacco-meal, the *Kölnische Zeitung* says, has been successfully used in agriculture for the destruction of noxious insects, but it has not yet been applied largely on account of its high price, which is caused by heavy import duty. The Prussian Minister for Agriculture has just addressed a letter to the Minister for Commerce with a view to reduce this duty or to take it off entirely. The only obstacle lies in the fact that the meal might be used for the manufacture of snuff. A Hamburg firm is said to have a stock of over thirty tons of this meal.

WE regret to learn that Mr. Alexander Agassiz, director of the Anderson School of Natural History, has been unable to make arrangements for a third session of this establishment during the present summer. He announced some time ago that, in view of the expense of the enterprise and the limited funds at his command, it would be impossible for him to proceed unless a sufficient number of students could be found willing to pay fifty dollars for the course. This appeal not proving effectual, he has given notice that the school will not be opened during 1875.

THE French Minister of Public Instruction has established a new commission to report on the state of meteorology and the improvements to be introduced in the system of observations, as hitherto practised at the Observatories of Paris and Montsouris, and other public establishments.

COL. MONTGOMERIE, the representative at the International Geographical Congress of the Royal Geographical Society and the Indian Survey Office, has arrived in Paris. A representative of the English Admiralty is expected very shortly. It is hoped that the Admiralty will send to Paris one of the magnificent yachts of the English navy for exhibition during the Congress. An immense quantity of goods for exhibition is stated to have already arrived from London.

THE death of Mr. Thomas Baines, the African traveller, is announced.

AT the last meeting of the Edinburgh Botanical Society, the *British Medical Journal* states, Dr. T. A. G. Balfour reported some interesting experiments on the *Dionœa muscipula*, which he considered a carnivorous plant. He showed that the irritability under which the leaf contracts is resident in six delicate hairs, so placed on the surface of the leaf that no insect could avoid touching them in crawling over. Chloroform dropped on a hair caused the leaf to close immediately; water had no such effect. Contraction only lasted for a considerable time when any object capable of affording nutrition was seized, when it lasted for about three weeks, and the interior of the leaf gave out a viscous acid secretion. A number of interesting points were made out with regard to the secretion, digestion, and absorption performed by the plant.

THE additions to the Zoological Society's Gardens during the past week include two Dorsal Squirrels (*Sciurus dorsalis*) from West Mexico, presented by Mr. John G. Haggard; a Yellow-shouldered Amazon (*Chrysotis ochroptera*) from South America, presented by Miss Amelia Grove Grady; a Grison (*Galictis vittata*) from South America, a Hobby (*Hypotriorchis subbuteo*), European, a Humboldt's Lagothrix (*Lagothrix humboldti*) from the Upper Amazon, purchased; ten Summer Ducks (*Aix sponsa*), seven Spotted-billed Ducks (*Anas pœcilorhyncha*), four Temminck's Tragopans (*Ceriornis temminckii*) bred in the Gardens.

RECENT PROGRESS IN OUR KNOWLEDGE OF THE CILIATE INFUSORIA *

II.

THE reproductive process was lately followed by myself through some of its stages in a very beautiful Vorticellidan obtained abundantly from a pond in Brittany.† The zooids which form the colonies in this Infusorium are grouped in spherical clusters on the extremities of the branches. They present near the oral end a large and very obvious contractile vesicle, and have a long cylindrical nucleus curved in the form of a horseshoe.

In the internal protoplasm are also imbedded scattered green chlorophylloid granules. No trace of the so-called nucleolus was present in any of the specimens examined.

Among the ordinary zooids there were usually some which had become encysted in a very remarkable way, and without any previous conjugation having been noticed. These encysted forms were much larger than the others and had assumed a nearly spherical shape; the peristome and cilia-disc had become entirely withdrawn, the contractile vesicle was still obvious, but had ceased to manifest contractions; brownish spherical corpuscles with granular contents, probably the more or less altered chlorophylloid granules of the unencysted zooid, were scattered through the parenchyma, and the nucleus was not only distinct, but had increased considerably in length. Round the whole a clear gelatinous envelope had become excreted.

In a later stage there was formed between the gelatinous envelope and the cortical layer of the body a strong, dark-brown, apparently chitinous case, the surface of which in stages still further advanced had become ornamented by very regular hexagonal spaces with slightly elevated edges. In this state the chitinous envelope was so opaque that no view could be obtained through it of the included structures, and in order to arrive at any knowledge of these it was necessary to rupture it. The nucleus thus liberated was found to have still further increased in length, and to have become wound into a convoluted and complicated knot. Along with the nucleus were expelled multitudes of very minute corpuscles with active Brownian movements.

In a still further stage the nucleus had become irregularly branched, and at the same time somewhat thicker and of a softer consistence; and finally, it had become broken up into spherical fragments, each with an included corpuscle resembling a true cell nucleus in which the place of a nucleolus was taken by a cluster of minute granules.

In this case the original nucleus of the Vorticellidan had thus become broken up into bodies identical with the so-called eggs of Balbiani, but this was unaccompanied by any conjugation or by the formation of anything which could be compared to spermatozoal filaments.

What I believe we may regard as now established in the phenomena of reproduction in the Infusoria is, that besides the ordinary reproduction by spontaneous fission of the entire body, the nucleus at certain periods, and after more or less change of form has occurred in the Infusorium body, becomes broken up into fragments, each including a corpuscle resembling a true cell nucleus; and that this takes place without necessarily requiring the influence of conjugation or the action of spermatozoa; that these fragments after their liberation from the body of the Infusorum become developed—still without the necessity of spermatic influence—directly or indirectly into the adult form.

Whether proper sexual elements ever take part in the life history of the Infusoria remains an open question.

Everts ‡ has given an account of observations which, with the view of testing the statements of Greeff, he made on *Vorticella nebulifera*. Greeff, as we have seen, followed Claparede and Lachmann in attributing to the Vorticellæ a true cœlenterate structure; and Everts, by his own investigations, has convinced himself of the untenableness of this view, and has been led to regard the Vorticellæ as strictly unicellular.

He recognises the distinction between the cortical layer (which forms not only the periphery of the body but the whole of the stalk on which this is supported), and the central mass in which the nutriment is deposited, collected into pellets and digested; but instead of regarding this central mass as chyme, he looks upon it as an integral constituent of the entire body, like the central portion of an Amœba. The nucleus is imbedded in the inner side of the cortical layer, which is itself differentiated into certain secondary layers. He describes the deeper part of the cortical layer as exhibiting a rotation of its granules independent of the rotation which occurs in the central parenchyma, and moving in a direction opposite to that of the latter. Everts's account of the structure of Vorticella is thus in accordance with the conception of it as a cell with a parietal nucleus; a cell, however, in which differentiation is carried very far without the essential character of a simple cell being thereby lost.

Everts regards the external wall as corresponding with the ectoderm, and the internal softer body-substance with the endoderm of higher animals. If by this the author meant to indicate a homological identity between the structures thus compared, it is plain that he would have taken an entirely mistaken view based on a misconception of the essential nature of an ectoderm and endoderm. These membranes are essentially multicellular, and are always results of the segmentation of the vitellus in a true ovum. They can therefore never be attributed to a unicellular animal, in which no true segmentation process ever takes place. In his rejoinder, however, to an elaborate criticism of his memoir by Greeff, he explains that he intended to compare the two layers of the Infusorium body analogically, not morphologically, with an ectoderm and endoderm.

The same author has further made some interesting observations on the development of Vorticella. He has noticed that reproduction is here ushered in by a longitudinal cleavage, in which after division of the nucleus the body of the Vorticella becomes cleft into two halves, still seated on the common stalk. Each of these develops near its posterior end a wreath of vibratile cilia, while the peristome and the cilia-disc over the mouth are entirely withdrawn, and then breaks loose from its stem and swims freely away. These free-swimming Vorticellæ now encyst themselves, the cilia disappear, and the contents of the encysted animal acquire a uniform clearness with the exception of the nucleus, which persists unchanged. In the next place the nucleus breaks up into eight or nine pieces, and then the wall of the cyst becomes ruptured and gives exit to these fragments, which now appear as spontaneously moving spherules. These increase in size, develop on one end a cilia wreath, within which a mouth makes its appearance, and the free-swimming nucleus-fragment becomes gradually changed into a form which entirely agrees with the *Trichodina grandinella* of Ehrenberg.

These Trichodinæ now multiply by fission, first developing a posterior wreath of cilia, and then dividing transversely between the anterior and posterior wreaths. After this each fixes itself by the end on which the mouth is situated; a short stem becomes here developed, and the cilia wreath gradually disappears. Then upon the free end the peristome and cilia disc make their appearance, and the growth of the stem completes the development.

Everts remarks that in this process we have an example of alternation of generations. There is one point, however, in which he has overlooked its essential difference from a true alternation of generations, namely, the absence of any intercalation of a proper sexual reproduction.

Ray Lankester * has subjected to spectrum analysis the blue colouring matter of *Stentor cæruleus*. This occurs in the form of minute granules in the cortical layer of the animal, and Lankester finds that it gives two strong absorption bands of remarkable intensity, considering the small quantity of the matter which can be submitted to examination. He cannot identify these bands with those of any other organic colouring matter, and to the peculiar pigment in which he finds them he gives the name of *stentorin*.

He has also examined the bright green colouring matter of *Stentor Mülleri*, and finds that instead of giving the stentorin absorption bands, it gives a single band like that of the chlorophylloid matter of *Hydra viridis* and of Spongilla.

Ray Lankester † has also described, under the name of *Torquatella typica*, a remarkable marine Infusorium, which, though quite destitute of true cilia, can scarcely be separated from the proper Ciliata. With the general structure of the ciliate Infusoria, the place of a peristomal cilia wreath is taken by a singular plicated membrane, which forms a wide, frill-like, very mobile appendage, surrounding the oral end of the animal, and projecting to a considerable distance beyond it. The author regards *Torquatella typica* as the type of a distinct section of the Ciliata to which he gives the name of *Calycata*.

Of all the authors who since Von Siebold have applied themselves to the investigation of the Infusoria, Haeckel must be mentioned as the one who has brought the greatest amount of evidence to bear on the question of their unicellularity. In a very elaborate paper which has quite recently appeared,[*] and which is remarkable for the clearness and logical acuteness with which the whole subject is treated, Prof. Haeckel, resting mainly on the observations of others, and partly also on his own, argues in favour of the unicellularity of the Infusoria from the evidence afforded both by the phenomena of their development and by the structure of the mature organism. He confines himself chiefly to the Ciliata—which, indeed, he regards as the only true Infusoria—while he considers the unicellularity of the Flagellata as too obvious to require an elaborate defence. The value of this paper will be obvious from the analysis of it which I now propose to give.

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* Anniversary Address to the Linnean Society, by the President, Dr. G. J. Allman, F.R.S., May 24. Continued from p. 137.

† British Association Reports, 1873.

‡ Everts, Untersuchungen an *Vorticella nebulifera*. Sitzungsberichte der Physikalisch-Medicinischen Societat zu Erlangen. 1873.

* Quart. Journ. Mic. Sci., 1873.

† Ibid. 1874.

In stating the argument derived from development, Haeckel does not accept as established the alleged sexual reproduction of the Infusoria, and he believes it safest to regard as non-sexual "spores" the bodies (*Keimkugeln*) which result from the breaking up of the nucleus, and which Balbiani regarded as eggs.

These bodies consist of a little mass of protoplasm usually destitute of membrane, and including a nucleus within which one or more refringent granules admitting of comparison with a true nucleolus may sometimes be witnessed—characters which are all those of a simple genuine cell. From this spore the embryo is developed by direct growth and differentiation of parts; but however great may be the differentiation, there is never anything like the formation of a tissue.

The development of the Infusoria is thus entirely in favour of the unicellular theory. This theory, however, is just as strongly supported by the study of their mature condition; and here Haeckel gives an admirable exposition of the structure of the true or Ciliate Infusoria.

The parts which are common to all Ciliata and which first differentiate themselves in the ontogenesis or development of the spore, are the cortical layer, the medullary parenchyma, and the nucleus, which is situated on the boundary between the two. The differentiation of the protoplasm of the naked spore into a clearer and firmer cortical substance, and a more turbid, granular, and softer medullary substance, corresponds entirely with what we see in the parenchyma cells of higher animals. These two products of differentiation are designated by Haeckel "exoplasm" and "endoplasm."

The exoplasm is originally a perfectly homogeneous and structureless, colourless hyaline layer distinguishable from the turbid granular soft protoplasm of the internal body mass, by containing in its composition less water, by absence of included granules, and by its high independent contractility. All the mobile appendages of the body, the cilia, bristles, spines, hairs, hooks, &c., are nothing but structureless extensions of this exoplasm and participate in its contractility. In this respect they entirely correspond to the cilia and flagellæ of the cells which form the ciliated epithelium of multicellular animals.

In many Ciliata we find this cortical layer or exoplasm itself subsequently differentiated into distinct strata. In the most highly differentiated Ciliata four layers may be distinguished as the result of this secondary differentiation of the exoplasm. These are: (1) the cuticle layer, (2) the cilia layer, (3) the myophan layer, (4) the trichocyst layer.

The *cuticle* is nothing but a lifeless exudation from the surface. In the majority of Ciliata there is no true cuticle, and in those which possess it, it presents itself under various forms, as seen in the thin, chitine-like, hyaline homogeneous pellicle of Paramæcum and Trichodina, the outer elastic layer of the stem of the Vorticellinæ, the protective sheath of Vaginicola, the chitin-like cases of the Tintinnodeæ and Codonellidæ, the beautiful lattice-like siliceous shells of the Dictyocystidæ, and many other shells, cases, and shield-like protections.[†]

The *cilia layer* occurs in all Ciliata; it lies immediately beneath the cuticle where this is present, and the whole of the cilia and other mobile appendages are its immediate extensions. These must therefore perforate the cuticle or its modifications when such protective coverings exist.

The *myophan layer* is identical with that which most authors describe as a true muscular layer. It has been demonstrated in most of the Ciliata. It appears as a system of regular parallel fine striæ in the walls of the body, and in the Vorticellidæ occupies also the axis of the stem, where it forms the characteristic "stem-muscle" of these animals. There can be no doubt that these striæ represent contractile fibrils, which, by their contraction, effect the various form changes of the animal. They are thus *physiologically* analogous to muscles. From a *morphological* point of view, however, we must regard them as only differentiated protoplasm filaments. In the morphological conception of true muscle, its cell nature is absolutely indispensable. The so-called muscle-fibrils of the Infusoria never show a trace of nucleus. They can be viewed only as *parts* of a cell due to the differentiation of the sarcode molecules of its protoplasm; and as they are thus only sarcode filaments, Haeckel designates them by the term "myophan," as indicating a distinction from proper muscle.

The *trichocyst layer* occurs also in many Infusoria, but not in all. It is a thin stratum of the exoplasm lying immediately on the endoplasm, and including in certain species the trichocysts. The presence of these bodies, which possess a striking resemblance to the thread-cells of the Cœlenterata, has, as we have already seen, been urged as an argument in favour of the multicellularity of the Infusoria. But, as Haeckel argues, no evidence of multicellularity can be derived from this fact. The thread-cells of the Cœlenterata are themselves the products of a cell, and we often find many of them originating in a single formative cell quite independently of the nucleus; the formative cell may in this respect be compared with the entire body of the Infusorium.

It is the endoplasm, or internal parenchyma of the Infusoria that has given rise to the most important differences of opinion, and in his account of this part of the Infusorium-organism Haeckel chiefly directs his criticism against the views advocated by Claparede and Lachmann, and by Greeff.

These authors, as we have already seen, compare the Infusoria with the Cœlenterata, and regard the endoplasm not as a real part of the body, but merely as the contents of the alimentary canal—as a sort of food mash or chyme contained in a spacious digestive cavity whose walls are at the same time stomach wall and body wall, and into which the mouth leads by a short gullet. As Haeckel urges, however, it needs only a correct conception of the intestinal cavity throughout the animal kingdom and of its distinction from the body cavity, in order to show the untenableness of this position. The main point of such a conception lies in the fact that the intestinal cavity and all extensions of it (gastro-vascular canals, &c.) are always originally clothed by the endoderm or inner leaflet of the blastoderm, while the body cavity is always formed on the external side of the endoderm, and between this and the ectoderm or outer leaflet of the blastoderm. The body cavity and intestinal cavity of animals are thus essentially different; they never communicate with one another, and always arise in quite different ways.

Again, the contents of a true intestinal cavity consist only of nutritious matter and water, in other words, of chyme; while the fluid which fills the body cavity is never chyme, but is always a liquid which has transuded through the intestinal wall, and which may be called chyle, or blood in the wider sense of the word.

Haeckel has thus taken, I believe, the true view of the intestinal and body cavities of animals. He had already advocated it in his work on the Calcareous Sponges. It necessarily involves a belief in the homological identity of organisation between very distant groups of the animal kingdom, a belief which all recent embryological research has only tended to confirm.

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[*] Haeckel, "Zur Morphologie der Infusorien." Jenaische Zeitschr., Band vii. heft 4, 1873.

[†] In the same number of the *Zeitschrift*, Haeckel ("Ueber einige neue pelagische Infusorien") describes some highly interesting Infusoria which spend their lives in the open sea and are distinguished by the possession of variously formed shells. His attention was first directed to them by finding their elegant empty shells in the extra-capsular sarcode of Radiolariæ. These pelagic Infusoria appear to belong to two different groups, which stand nearest to the Tintinnodeæ of Claparede and Lachmann. He designates them as *Dictyocystidæ* and *Codonellidæ*.

The family of the Dictyocystidæ is based on Ehrenberg's *Dictyocysta*, and is characterised by the possession of a siliceous perforated lattice-like shell so closely resembling that of many Radiolariæ, that Haeckel at first mistook it for the shell of one of these. The shell is in all the species bell-shaped or helmet-shaped, and the body of the animal, which is fixed to the fundus of the bell, and can be projected far beyond its margin, has a wide funnel-shaped peristome on whose edge are two concentric wreaths of strong cilia. He describes four species, distinguishing them by characters derived from their siliceous latticed shell

The family of the Codonellidæ, based on the genus *Codonella*, Haeckel, is also provided with a bell-shaped case, but this, instead of being formed of a siliceous lattice work, consists of a chitine-like organic membrane, through which siliceous particles are scattered. The family is, however, chiefly characterised by the peculiar form of its peristome. This is funnel-shaped and provided on its margin with a thin collar-like expansion. The free edge of this collar is serrated, and each tooth carries a stalked lobe of a piriform shape, regarded by Haeckel as probably an organ of touch. At some distance behind the circle of piriform lobes is situated a ring of long, strong, whip-like cilia, which form powerful swimming organs. The three species described are distinguished by the form of their chitinous cases.

(*To be continued.*)

SCIENTIFIC SERIALS

American Journal of Science and Arts, June.—The original articles in this number are :—Results of dredging expeditions of the New England Coast in 1874, by A. E. Verrill. More than 100 species new to the fauna of southern New England were secured. Most of these are northern species, but many are undescribed. A table giving nature of bottom and temperature at the surface and bottom of the sea is given.—Mr. Fontaine's paper on the Primordial Strata of Virginia is continued and concluded. At the end is given a comparison with the metamorphic crystalline rocks of the Blue Ridge.—On the occurrence of the Brown Hematite deposits of the Great Valley, by Frederick Prime, jun.—Note on some new points in the elementary stratification of the Primordial and Canadian rock of south central Wisconsin, by Roland Irving. The order for the Lower Silurian strata of Wisconsin has been generally accepted as (beginning from below) 1. Potsdam sandstone ; 2. Lower magnesian limestone ; 3. The St. Peter's sandstone ; 4. The blue and buff limestones ; 5. The Galena limestone ; 6. The Cincinnati group. The succession as now made out is (beginning from below) 1. The Lower or Potsdam sandstone ; 2. The Mendota limestone ; 3. The Madison sandstone ; 4. The main body of limestone ; 5. The St. Peter's sandstone. A table of correlation is given with the Mississippi Bluffs and the Minnesota River.—On the application of the horizontal pendulum to the measurement of minute changes in the dimensions of solid bodies, by Prof. O. N. Rood.—On diabantite (a chlorite), by G. W. Hawes.—Re-discovery of double star H.I. 41, by S. W. Burnham. It is about 46′ north of the well-known double star ψ' Draconis, and is easily found without an equatorial mounting.—On the distribution of electrical discharges from circular discs, by C. J. Bell.—Examination of gases from the meteorite of Feb. 12, 1875, by A. W. Wright.—On limonite with the colour and transparency of göthite, by Prof. Mallet.—Under the head "Scientific Intelligence," the original notes are :—On the surface geology of Ohio ; On the Prototaxites of Dawson ; On the Crustaceans of the caves of Kentucky and Indiana, together with several reviews.

Fourth and Fifth Annual Reports of the Wellington College Natural History Society, Dec. 1872 to Dec. 1874.—We are gratified to see that this Society is in a much more hopeful condition than it was when we noticed its last Report, the tone of which was almost despairing. The attendance has been very much better, and the interest taken in the Society by the boys is evidently increasing. Judging from the lists a fair amount of field-work in natural history has been done, and the Society is gradually forming good collections. But, as the preface to one of the Reports hints, there is still much room for improvement in the subjects and character of the papers read at the meetings. Except in the case of lectures by outsiders, the majority of the papers are the result of reading and not of observation or experiment, and not many of them can strictly be called scientific. Now, however useful such exercises as these may be to the boys, this is scarcely the sort of work one looks for from members of a Natural History Society. We think this Society might well take a leaf out of the Rugby Society's Report, and go in much more extensively for organised field-work, encouraging the boys to use their eyes and their hands on nature as well as on books, and to bring forward papers embodying the results of their observations, papers of a character similar to the interesting one of the president, the Rev. C. W. Penny, on "Natural History in the Christmas Holidays." Not only would the members thus reap much benefit, both in the way of discipline and instruction, but we are sure a greater interest in the Society would be created in the School. The Society has evidently got a good second start, and we trust that the next Report will show as great an advance on the two under notice as these do on the previous one.

Riga Society of Naturalists.—Nos. 8 and 9 of this Society's publications contain three papers of importance, besides meteorological reports and notes of smaller interest. The more important papers are : On some theories of earthquakes, by Prof. Schweder.—On the changes in the Düna estuary, by M. Gottfried.—On the fauna of Spitzbergen, by Prof. Nordenskjöld, showing that this fauna consists of 15 species of quadrupeds, 23 of birds, 23 of fishes, 64 of insects, 100 of Crustaceæ, and 130 of sea molluscs.—There is also an obituary notice of the late Dr. Ernst Nauck, who died at Riga on Jan. 26 last.

SOCIETIES AND ACADEMIES

London

Royal Society, June 10.—"Experiments on Stratification in Electrical Discharges through Rarefied Gases," by William Spottiswoode, M.A., Treas. R.S.

In the stratified discharges through rarefied gases produced by an induction-coil working with an ordinary contact-breaker, the striæ are often unsteady in position, and apparently irregular in their distribution. Observations made with a revolving mirror, which the author hopes to describe on another occasion, have led him to conclude that an irregular distribution of striæ does not properly appertain to stratification, but that its appearance is due to certain peculiarities in the current, largely dependent upon instrumental causes.

The beautiful and steady effects obtained by Mr. Gassiot with his Leclanché battery, and also more recently by Mr. De la Rue with his chloride-of-silver battery, have abundantly shown the possibility of stratification free from the defects above mentioned ; but it must be admitted that the means employed by those gentlemen are almost gigantic. The present experiments were undertaken by the author with the view of ascertaining, first, how far it was possible to approach towards similar results with instruments already at his command ; and secondly, whether these would afford other modes of attack, beside the battery, on the great problem of stratified discharges.

The induction-coil used was an "18-inch" by Apps, worked occasionally by six large chloride-of-silver cells, kindly lent the the author by Mr. De la Rue, but more usually by ten or by twenty Leclanché cells of the smallest size ordinarily made by the Silvertown Company. He has also, in connection with the same coil, 120 of the latter cells, connected in twenties for quantity, and forming six cells of twenty times the surface of the former. These work the coil with the ordinary contact-breaker very well, giving 11-inch sparks whenever required. A "switch" affords the means of throwing any of the three batteries in circuit at pleasure.

Having reason to think that the defects in question were mainly due to irregularity in the ordinary contact-breaker, he constructed one with a steel rod as vibrator, having a small independent electromagnet for maintaining its action. The details of construction of this contact-breaker are described.

With a contact-breaker of this kind in good action, several phenomena were noticeable ; but first and foremost was the fact that in a large number of tubes (especially hydrocarbons), the striæ, instead of being sharp and flaky in form, irregular in distribution and fluttering position, were soft and rounded in outline, equidistant in their intervals, steady in proportion to the regularity of the contact-breaker. These results are, the author thinks, attributable more to the regularity than to the rapidity of the vibrations. And this view is supported by the fact that, although the contact-breaker may change its note (as occasionally happens), and in so doing may cause a temporary disturbance in the stratification, yet the new note may produce as steady a set of striæ as the first. And not only so, but frequently there is heard, simultaneously with a pure note from the vibrator, a strident sound, indicating that contacts of two separate periods are being made, and yet, when the strident sound is regular, the striæ are steady. On the other hand, to any sudden alteration in the action of the break (generally implied by an alteration in the sound) there always corresponds an alteration in the striæ.

The author then attempts to show the extreme delicacy in action of this kind of contact-breaker, or "high break," as it may be called.

The discharges described above are usually (although not always) those produced by breaking contact ; but it often happens, and that most frequently when the strident noise is heard, that the current produced by making contact is strong enough to cause a visible discharge. This happens with the ordinary as with the high break ; but in the latter case the double current presents the very remarkable peculiarity, that the striæ of one current are so arranged as to fit exactly into the intervals of the other. And further, that any disturbance affecting the column of striæ due to one current affects similarly, with reference to absolute space, that due to the other, so that the double column moves, if at all, as a solid or elastic mass. And this fact is the more remarkable if we consider, as is easily observed in a revolving mirror, that these currents are alternate, not only in direction, but also in time, and that no one of them is produced until after the complete extinction of its predecessor. And it is also worthy of note that this association of striæ is not destroyed, even when the two currents are separated more or less towards opposite sides of the tube by the presence of a magnetic pole. There seems, however, to be a tendency in that case for the striæ of one current to advance upon the positions occupied by those of the reverse current, giving the whole column a twisted appearance. But as there is no trace, so far as the author's observations go, of this association of alternate discharges when produced by the ordinary break, we seem led to the conclusion that a stratified discharge, on ceasing, leaves the gas so distributed as to favour, during a very short interval of time, a similar stratification on the occurrence of another discharge, whether in the same or in the opposite direction. An explanation of the fact that the striæ of alternate discharges occupy alternate and not similar positions is not obvious, and probably demands a better knowledge of the nature of the striæ than we possess at present.

The column of striæ, which usually occupy a large part of the tube from the positive towards the negative terminal, have hitherto been described as stationary, except as disturbed by irregularities of the break. The column is, however, frequently susceptible of a general motion, or "flow," either from or towards the positive pole, say a forward or backward flow. A similar phenomenon was observed by Mr. Gassiot in some tubes with his large battery, but the author is not acquainted with the exact circumstances under which it was produced. This flow may be controlled, both in velocity and in direction, by resistance introduced into the circuit, or by placing the tube in a magnetic field. The resistance may be introduced in either the primary or the secondary circuit. For the former arrangement the author successfully employed a set of resistance-coils, supplemented by a rheostat. For the secondary current, as well as for the Holtz machine, he has used an instrument devised and constructed by his assistant, Mr. P. Ward, to whose intelligence and skill he is much indebted throughout this investigation, intended for fine adjustment. Wherever the resistance be introduced the following law appears to be established by a great number and variety of experiments, viz., that, the striæ being previously stationary, an increase of resistance produces a forward flow, a decrease of resistance a backward flow. The author has generally found that a variation of 3 or 4 ohms, or, under favourable conditions, of 1 or 2 ohms, is sufficient to produce this effect. But as an alteration in the current not only affects the discharge directly, but also reacts upon the break, the effect is liable to be masked by these indirect causes. The latter, so far as they are dependent upon a sudden alteration of the resistance, may be diminished by the use of the rheostat; but when the striæ are sufficiently sensitive to admit the use of this delicate adjustment, some precautions are necessary to ensure perfect uniformity of current, so as to avoid disturbances due to uneven contact in the rheostat itself.

When the striæ are flowing they preserve their mutual distances, and do not undergo increase or decrease in their numbers. Usually one or two remain permanently attached to the positive electrode; and as the moving column advances or recedes, the foremost stria diminishes in brilliancy until, after travelling over a distance less than the intervals between the two striæ, it is lost in darkness. The reverse takes place at the rear of the column. As the last stria leaves its position, a new one, at first faint and shadowy, makes its appearance behind, at a distance equal to the common interval of all the others. This new one increases in brilliancy until, when it has reached the position originally occupied by the last stria, when the column was at rest, it becomes as bright as the others. The flow may vary very much in velocity; it may be so slow that the appearances and disappearances of the terminal striæ may be watched in all their phases, or it may be so rapid that the separate striæ are no longer distinguishable, and the tube appears as if illuminated with a continuous discharge. In most cases the true character of the discharge, and the direction of the flow, may be readily distinguished by the aid of a revolving mirror. In some tubes, especially in those whose length is great compared with their diameter, the whole column does not present the same phase of flow; one portion may be at rest while another is flowing, or even two conterminous portions may flow in opposite directions. This is seen also in very wide tubes, in which the striæ appear generally more mobile than in narrow ones. But in all cases these nodes or junction-points of the flow retain their positions under similar conditions of pressure and current; and it therefore seems that, under similar conditions, the column in a given tube always breaks up into similar flow-segments.

These nodes will often disappear under the action of a magnetic pole. Thus, if the first segment, measured from the positive terminal, be stationary and the second be flowing backwards (*i.e.* from − to +), a magnetic pole of suitable strength, placed at the distant end of the latter, will stop its flow, and the whole column will become stationary throughout. An increase in the strength of the magnet, or a nearer approach of it to the tube, will produce a general forward flow of the column.

The phenomena of the flow, as well as others of not less interest, are capable of being produced with the Holtz machine. It is well known that stratified discharges, similar to those produced by an induction-coil working with an ordinary break, may be produced by such a machine, provided that it be furnished with the usual Leyden jars, and a high resistance (usually a piece of wetted string) be interposed in the circuit. The absence of either of these conditions was supposed to destroy the striæ and to render the discharge continuous. Experiments which the author has recently made, but do not describe on the present occasion, tend in part, but only in part, to confirm this view. They show that for the production of striæ both quantity and resistance are necessary, that the discharge must occupy a certain short, perhaps, but finite time, or, as it may also be expressed, that a continuous current is an essential element.

Now, seeing that every tube must offer some resistance, and also that by adjusting the height of the vertical condensors of the machine (or length of air-spark interposed in the circuit) we had the means of altering the quantity in the discharge, it seemed worth while to try whether, by a suitable adjustment of the parts, phenomena similar to those brought out by the coil and high break might not be produced by the machine. And this proved to be very easy of attainment in tubes which had been successfully used by the coil; and not only so, but the character of the flow therein shown confirmed in a very striking and simple manner the effects of resistance described above.

The connections being made in the usual way, and no air-spark being admited into the circuit, a vacuum-tube of carbonic oxide, about 60 centims. in length and 4·5 centims. in outside diameter, gave, when the plates of the machine revolved at about six times per second, a rather confused discharge. As the speed was increased a rapid forward flow of the striæ was readily discerned; and on a still further increase to about ten revolutions per second, the flow, first in one part and then throughout nearly the whole length of the tube, slackened its pace and stopped, and ultimately reversed its motion. An increase of speed is equivalent to an overcoming or a diminution of resistance in the circuit, a diminution of speed to an augmentation of resistance. Hence the phenomena of flow produced by the machine agree with those produced by the coil.

The author concludes by referring to the effects obtained with sulphurous acid and other tubes, and by describing the resistance-coil used for the secondary current.

Chemical Society, June 17.—Prof. Abel, F.R.S., in the chair.—Notes on the chemistry of tartaric and citric acid, by Mr. R. Warrington, gives many important particulars connected with the manufacture of these acids: and also detailed accounts of the methods of analysis—many of them novel—of the various raw materials from which they are made.—After this the Secretary read a communication on the action of nitric acid on copper, mercury, &c., especially in the presence of metallic nitrates, by Mr. J. J. Ackworth.—Dr. Gladstone then gave a short account of the decomposition of water by the joint action of aluminium and aluminium iodide, bromide, and chloride, including instances of reverse action, by himself and Mr. Tribe.—The other papers were on nitrosyl-bromide and on sulphuro-bromide, by Mr. M. M. P. Muir.—On achrematite, a new molybdo-arseniate of lead from Mexico; and on certain new reactions of tungsten, both by Prof. J. W. Mallet; and on the action of chlorine on acetamide, by Dr. Prévost.

Geological Society, June 9.—John Evans, V.P.R.S., president, in the chair.—The following communications were read:

—On *Prorastomus sirenoïdes*, Owen. (Part II.), by Prof. Owen, F.R.S. The author has submitted the skull of a Sirenian from Jamaica, described by him in 1855 under the name of *Prorastomus sirenoides*, to a careful re-examination; and in this paper notices the characters revealed by further removal of the matrix, and discusses the bearings of the facts thus ascertained upon the relations of the animal and of the Sirenia generally. The parts which have been brought to light are the base and roof of the cranium, the zygomatic arches, the hind half of the mandible, with the articular part of the condyle, and the greater part of the atlas. The characters presented by these parts are described in detail, and the characters of the genus are compared with those presented by other genera of Sirenians, both living and fossil, especially *Manatus* and *Felsinotherium*. The dental formula of *Prorastomus* is given as—

$$i.\ \frac{3-3}{3-3?},\ d.\ \text{or}\ c.\ \frac{1-1}{1-1},\ p.\ \frac{5-5}{5-5},\ m.\ \frac{3-3}{3-3} = 48:$$

thus, as in *Manatus*, showing an excess in the molar series over the type of the terrestrial herbivorous mammalia, whilst the incisors and canines retain the common type as to number and kind, and have not been subjected to so great a degree of suppression or of individual excess of development as in existing Sirenians. The presence of these small subequal incisorsin both jaws of *Prorastomus* is the most marked feature in which *Prorastomus* adheres to the normal mammalian type, while showing the essential characters of the marine Herbivores; but a similar tendency is shown in other parts of the skull. The author regards the Sirenia as essentially monophyodont. *Halicore* and *Felsinotherium* depart further from the type than *Halitherium* and *Manatus*, and these than *Prorastomus*. *Rhytina*, with a better developed brain and with the jaws edentulous when adult, is an extreme modification of the Sirenian type. The rudimentary femur in *Halitherium* is to be regarded as the result of degeneration through lack of use, from better-limbed prototypal mammals. With respect to the genealogy of the Sirenia, the author remarks that Häckel derives the Sirenia, Zeuglodontes, and Cetacea, together with the Artiodactyla, from the branch Ungulata, and the Perissodactyla from the branch Pycnoderma of the Mammalian trunk; but that while *Halitherium* and *Felsinotherium* show the molar pattern of *Hippopotamus*, *Prorastomus* exhibits that of *Lophiodon* and *Tapirus*, to which *Manatus* also adheres rather than to any Artiodactyle type. The author suggests that both Ungulates and Sirenians diverged at some remote period from a more generalised (cretaceous?) mammalian gyrencephalous type? and that the marine Herbivora in the course of long Eocene and Miocene eons were subjected to conditions producing modifications of their molars, leading on one side to an Artiodactyle and on the other to a Perissodactyle character. As *Prorastomus* by its more generalised dentition and shape of brain represents a step nearer the speculative starting-point than any other Sirenian, it acquires a great interest, and the determination of the precise age of the (supposed Eocene) bed from which its remains were derived is very much to be desired.—On the structure of the skull of *Rhizodus*, by L. C. Miall, F.G.S. In this paper the author described a large skull of *Rhizodus* from the coal-shale of Gilmerton, near Edinburgh. The characters described show that *Rhizodus* is a Ganoid fish, and that its position in the order is not far from *Holoptychius* and *Megalichthys*. The author referred it to the cycloidal division of the family Glyptodipterini.—Appendix to a note on a modified form of Dinosaurian Ilium, hitherto reputed Scapula, by Mr. J. W. Hulke, F.R.S.—This paper contained a notice of the pubis of *Iguanodon*, which proves to be identical with the smaller of the two specimens figured by the author in a former paper (Quart. Journ. Geol. Soc. xxx. pl. xxxii. Fig. 1). When inverted, its long slender process is easily identified with that of the pubis of the nearly allied *Hypsilophodon*, and this slanted downwards and backwards parallel to the ischium, the little process of its posterior surface, meeting a corresponding process of the ischium, and converting the upper end of a long narrow obturator space into a foramen. The pubis of *Iguanodon* contributed largely to the formation of the acetabulum, thus resembling that of existing Lacertilia, as also in its possession of a broad ventral extension, probably united with that of the opposite side by a median symphysis. The specimens described in this paper were collected in the Isle of Wight by the Rev. W. Fox.—Notes on the Palæozoic Echini, by Mr. Walter Keeping, of the Woodwardian Museum, Cambridge; communicated by Prof. T. M'Kenny Hughes, F.G.S. The author alluded to the interest excited by the discovery of Echinoderms with flexible tests; and having pointed out the difference between the more modern and the Palæozoic forms (their plates imbricating in opposite directions), gave a description of the following forms:—(1) *Perischodomus*; (2) *Ræchinus*, g.n., sp. *R. irregularis* (Keeping); (3) *Palæchinus* (?) *intermedius* (Keeping); (4) *Palæchinus gigas* (McCoy); (5) *Palæchinus sphæricus* (McCoy); (6) *Archæocidaris Urii* (Fleming). In conclusion, the author proposed a new method of classification for the *Echinoidea*. He also noticed the existence in the Museum of the Royal School of Mines of a British fossil which appears to belong to the group of Echinoidea with numerous ranges of ambulacral plates, represented in America by the genera *Melonites*, *Oligoporus*, and *Lepidesthes*.—On some fossil Alcyonaria from the Australian Tertiary deposits, by Prof. P. Martin Duncan, F.R.S. In a former communication in 1870 the author described some fossil corals from the Tertiary strata near Cape Otway, in the province of Victoria. In one, which he called the "Upper Coralline bed," the equivalent of the Polyzoan limestone of Woods, he found specimens which he did not then describe, as they were not true corals. Belonging to the Isidinæ, and not being of great interest, he retained them until the receipt of some similar specimens from New Zealand, described in the following paper. The Australian forms described by the author were shown to be nearly allied to the recent *Isis hippuris* and the fossil *I. corallina*.—On some fossil Alcyonaria from the Tertiary deposits of New Zealand, by Prof. P. Martin Duncan, F.R.S. The New Zealand fossils referred to in the preceding paper were sent to the author by Capt. F. W. Hutton, F.G.S.; they were derived from the Awawoa Railway cutting, and were from the upper part of the Oawaru formation. They consisted of fragments of species of the genus *Isis* and of *Corallium*. These were compared with those from the Australian Tertiaries, and the author inferred that both deposits were formed under similar conditions, and that they were at least homotaxial, whatever their precise geological age might be.—On some fossil corals from the Tasmanian Tertiary deposits, by Prof. P. Martin Duncan, F.R.S. The author described a new species of *Dendrophyllia* possessing very unusual characters, the epitheca replacing the true wall, and giving the specimen a marked Palæozoic appearance. The fossil was obtained from a Tertiary deposit, and was associated with *Placotrochus deltoideus*, a well-marked coral, characteristic of a definite geological horizon in Victoria, namely, the lower beds of the Cape Otway section, belonging to the Lower Cainozoic period. For this coral he proposed the name of *Dendrophyllia epithecata*. A much worn reef-coral was found associated with the above.

Meteorological Society, June 16.—Dr. R. J. Mann, president, in the chair.—The following papers were read:—On a white rain or fog bow, by Mr. G. J. Symons.—On a proposed form of thermograph, by Mr. Wildman Whitehouse, F.R.A.S.—On the rainfall at Athens, by Prof. V. Raulin (translated by Mr. R. Strachan). These observations were made by M. Julius Schmidt, director of the Greek Observatory, and embrace a period of twelve years and a half, viz., from August 1859 to December 1871. The average yearly fall is 15·83 inches, and the average number of wet days ninety-three. The wettest year was 1864, when 28·30 inches fell, and the driest 1862, with 9·63 inches.—On the barometric fluctuations in squalls and thunderstorms, by the Hon. Ralph Abercromby. There are two classes of storms in this country: in one the barometer rises, in the other it falls. The author in the present paper only refers to the former. After mentioning some of the phenomena which accompany storms of this class, he proceeds to give two instances as typical of their general character. In conclusion he makes the following remarks on their origin:—Though in this country squall-storms are almost always associated with primary or secondary cyclones, those in India and Africa are not connected with cyclones, and hence the source of the barometric rise cannot be due to any special phenomenon of cyclone motion. Since the rise is always under the visible storm, it is propagated at the same rate and in the same manner as thunderstorms. Enough is known of the course of the latter to be certain that they are not propagated like waves or ripples, and hence these small barometric rises are not due to aërial waves, as has sometimes been suggested. Since the general character of the rise is the same whether there is thunder or not, it is evident that electricity, even of that intensity which is discharged disruptively, is not the cause of the rise. If we look at a squall from a distance, we always see above it cumulus, which is harder and more intense in the front than in the rear of the squall. Since cumulus is the condensed summit of an ascensional column of air, it is evident that the barometric rise takes place under an uptake of air. If we consider further that a light ascensional current would give rise simply to an overcast sky, a stronger one to rain, while a still more violent one would project the air suddenly into a region so cold and dry that the resulting electricity would be discharged disruptively as lightning, the foregoing observations show that the greatest rise is under the greatest uptake. Some meteorologists attribute the low pressure at the equator to the ascending current formed at the junction of the trades; while others attribute the 10 A.M. maximum of the diurnal range of the barometer to the reaction of an ascending column of air due to the increasing heat of the day. The above observations tend to strengthen the view that an ascending column of air gives rise to a reactionary pressure downwards, and more generally to the idea that though the total pressure shown by the barometer is principally statical, or due to the weight of a definite column of air, a small portion is dynamical, or due to the reaction of air motion in that column.—Notes on solar radiation in its relation to cloud and vapour, by Mr. J. Park Harrison.—Mr. Scott also exhibited and described Lowe's graphic hygrometer.

Zoological Society, June 15.—Prof. Newton, F.R.S., V.P., in the chair.—A letter was read from Dr. A. B. Meyer, of Dresden, stating that having inquired into the statement made by Mr. Bruyn (P.Z.S., 1875, p. 30), that he had specimens of four species of Birds of Paradise alive in his possession at Ternate, he had ascertained that the foundation for this statement was that Mr. Bruyn expected to receive specimens of other species, but had only actually obtained examples of one of them (*Paradisea papuana*).—Mr. George Dawson Rowley exhibited and made remarks on some specimens of two diminutive Parrots from New Guinea (*Nasiterna geelvinkiana* and *N. pygmæa*).—Sir Victor Brooke exhibited and made remarks on two original drawings by Mr. Wolf of the two species of Koodoo, *Tragelaphus strepsiceros* and *T. imberbis*. The latter was taken from a specimen received direct from the Juba River, Somali. The exact habitat of this species had not before been determined.—Prof. Owen, C.B., read a paper in which he gave the description of some bones of *Harpagornis moorei*, sent to him by Dr. Haast, which had been found in the turbary deposits of Glenmark, a locality about forty miles from Christchurch, New Zealand. This paper formed the twenty-first part of Prof. Owen's series of memoirs on the extinct birds of the genus *Dinornis* and its allies.—Mr. G. E. Dobson communicated the descriptions of some new species of bats of the genus *Vesperugo*.—A communication was read from Mr. George Gulliver, F.R.S., containing observations on the sizes and shapes of the red corpuscles of the blood of Vertebrates. These observations were accompanied by a series of drawings of these objects, and by extended and revised tables of measurements.—A communication was read from the Rev. S. J. Whitmee, of Samoa, respecting the changes he had observed in the habits of feeding, roosting, and building of the *Didunculus strigirostris*.—A second paper by Mr. Whitmee gave an account of the times of appearance of the Edible Marine worm (*Palola viridis*) in the islands of the Samoan group, together with observations on its habits.—A communication was read from Dr. J. S. Bowerbank, containing the fourth of a series of memoirs on the Siliceo-fibrous sponges.—Sir Victor Brooke, Bart., and Mr. A. Basil Brooke read a joint paper on the large Asiatic Wild Sheep or Argalis. Of these animals they recognised eight species, viz.: *Ovis ammon*, from the Altai between the Sea of Baikal and Thian Shan; *O. karelini*, from the Thian Shan; *O. poli*, from the Pamir; *O. hemsii*, from the Alexandrian Mountains; *O. nigrimontana*, from the Karatau; *O. hodgsoni*, from Little Thibet; *Ovis nivicola*, from the Stanovoi Mountains and Kamschatka; and *Ovis brookei*, of which the habitat was unknown.—Mr. Sclater read a paper on the Rhinoceroses now or lately living in the Society's Menagerie.

Victoria (Philosophical) Institute, June 21.—The Rev. Isaac Taylor, M.A., read a paper on the Etruscan language. After stating the causes which had made this language so long a mystery, the lecturer gave an account of the origin of the Etruscan alphabet, and of the information as to the nature of the language which is supplied by the bilingual inscriptions. He then gave an account of the inscribed dice, which he held to be the key to the Etruscan secret. He fully explained the Etruscan system of numeration, and showed that the numerals, the vocabulary, the grammar, and the mythology of this people all pointed to a Turanian origin.

PARIS

Academy of Sciences, June 14.—M. Frémy in the chair.—The following papers were read:—On the discovery of the two minor planets (144) and (145) by Director Peters, and (146) by M. Borrelly.—A note by M. Chevreul, on the explanation of numerous phenomena which appear as a consequence of old age.—Researches on solar radiation (continuation) by M. P. Desains.—On the synthesis of camphors by the oxidation of camphenes, by M. Berthelot.—On the water-spout which occurred near Caen in 1849, by M. Faye.—Some remarks, in complement to his note read before the Academy in May 1873 by M. Weddell, on the part played by the substratum in the distribution of Lichens inhabiting rocks.—A note by MM. E. Belgrand and G. Lemoine, on the probable decrease of flowing water in the basin of the Seine during the summer and autumn of 1875.—Report of the Commission which was appointed to examine a proposed new method in the construction of lightning conductors for powder magazines.—On the theory of revolution surfaces which, by way of deformation, can be superposed on one another, and each on itself in all its parts (second paper), by M. F. Reech.—A note by M. Sekowski, on a system of distribution in steam-engines.—On the synthesis of terpilene or carburetted camphene, by M. G. Bouchardat.—A note by M. Barthelemy, on a process to measure the co-efficient of the absolute dilatation of mercury.—A note by M. A. Rivière on the appearance of sedimentary formation in the granitic rocks now used for the pavements in the Paris streets.—A note by M. E. Jourdy on the shape of bays in the Algerian district.—A memoir by M. L. V. Turquan, on the integration of the equation with partial derivatives of the third order, and two independent variables.—A note by M. Lecoq de Boisbaudran, on the theory of dissolution and of crystallisation.—Report of the falling of two meteoric stones in the United States, by M. J. Lawrence Smith, of Louisville (Ky.). The author gives a minute description and an analysis of these two meteorites.—On the influence of forests upon the climate, and on the variation of temperature with the phases of vegetation, by M. L. Fautrat.

BOOKS AND PAMPHLETS RECEIVED

FOREIGN.—Aunales del Museo Publico de Buenos Aires.—Annalen des Physikalischen Central Observatoriums for 1873: H. Wild (Russia).—Morphologisches Jahrbuch. Eine Zeitschrift für Anatomie und Entwickelungsgeschichte: C. Gegenbaur (Leipzig, W. Engelmann).—Die Neue Schöpfungsgeschichte: Arnold Dodel (Leipzig, F. N. Brockhaus).—Handbuch der Zoologie. 3 vols.: J. Victor Carus and C. E. A. Gerstaeker (Leipzig, W. Engelmann).—Boletin de la Academia Nacional de Ciencias Exactus existante en la Universidad de Cordoba, Buenos Aires.—Jahrbücher für Wissenschaftliche Botanik: Dr. N. Pringsheim (Leipzig, Wm. Engelmann).—Sie Alcundi Principj di Elettrostatica. Serie di Esperienze del Prof. G. Cantoni (Milan, F. Vallardi).—Salla Polarizzione dei Coibenti: Prof. G. Cantoni.—Efficacia dei Vapori nell 'Interus dei liquidi: Prof. G. Cantoni.—Sul limite di resistenza nei Coibenti Elettrica: Prof. G. Cantoni.—Importante Osservazioni di C. B. Beggaria sui Condensatori Elettrica: Prof. G. Cantoni.—Sie Talune particolari Forme di Cirri: Prof. G. Cantoni.—Sperienze d'Elettrostatica (two parts): Prof. G. Cantoni.—Nuvoa Serie di Sperimenti su l'Eterogenia: Prof. G. Cantoni.—Verdhandlungen des Vereins für Naturwissenschaftliche Unterhaltung zu Hamburg, 1871–74: J. D. E. Schmelz (Hamburg, L. Friederischen und Co.)—Jahrbuch der k. k. Geologischen Reichsanstalt. No. 1, 1875 (Wien).—Uber die Palæozoischen Gebilde Podoliens und deren Versteinerungen: Dr. Alois v. Alth (Wien).—Uber die Triadischen Pelecypoden: Gattungen, Daonella und Halobia: Dr. E. M. v. Mojsvár (Wien).—Die Culm Flora des Mahrisch Schlesischen Dachechieffers: Dr. Steer (Wien).

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THURSDAY, JULY 1, 1875

SIR WILLIAM EDMOND LOGAN

BY the death of this illustrious geologist and most genial man, science has been deprived of one of her bravest and best soldiers, while those who personally knew him have lost a true, warm-hearted friend.

One by one the magnates by whose toil geology rose during the first half of this century are taken from us. Link after link is broken in the chain of living men who have served to bind us personally with the birth and infancy of that science. Few were left to us, and of these few none more honoured and beloved than the veteran who has just been called away. Of Scottish parentage (his father having been a landed gentleman in Stirlingshire, who had emigrated to Canada), W. E. Logan was born at Montreal in the year 1798. He was sent home to the old country for his education, and studied, it is believed, both at the High School and the University of Edinburgh. Eventually, having developed an ardent love for geological pursuits, he settled in South Wales and began to study the structure of the great coal-field of that region. It was there that he fostered that habit of patient and exact observation, combined with quickness of eye in seizing the salient points in the geological structure of a region, which stood him in such good stead in later life. During a series of years he carefully followed the outcrops of the various coal-seams, tracing the positions of the numerous faults by which they are traversed, and putting all his data upon the one-inch sheet of the Ordnance Survey. These maps of the South Welsh coal-field were probably the first in this country, on so large a scale and of so extensive a district, where the details of geological structure were depicted with such minuteness. They were generously handed over to Sir Henry de la Beche when he began the Geological Survey in that region, and he found them so admirable that he adopted them for the Government Survey, on the early sheets of which the name of W. E. Logan is engraved in conjunction with those of De la Beche, Ramsay, Phillips, and Aveline. He worked on the staff of the Survey as an enthusiastic volunteer, lending invaluable assistance in the South Welsh region, and among other services introducing horizontal sections on a true scale of six inches to a mile, which served as models for the large sections of the Survey.

One of the most important observations made by Logan during this early part of his career was one relating to the origin of coal. He pointed out, what is now so universally recognised and yet does not seem ever to have struck anybody before, that each coal-seam rests upon an underclay or fireclay in which rootlets of *Stigmaria* branch freely in all directions. This association of coal and *Stigmaria*-clay he found to be so general that it could not be regarded as accidental. He suggested that the clay represented an ancient soil or mud in which the *Stigmaria* grew, and that the coal stood now in place of the matted vegetation which grew upon that soil. The value of this contribution to our knowledge of the history of coal and of the changes in physical geography to which the stratified rocks bear witness, can hardly be over-estimated.

In the summer of 1841 Mr. Logan went to America and spent the autumn of that year in explorations of the coalfields there. He examined the Pennsylvanian region, which had been studied by Rogers, and afterwards went through the coal-districts of Nova Scotia, where he made some original observations. He spent the winter of 1841-1842 in Canada, devoting himself among other things to watching the behaviour of ice as a great geological agent on the rivers. In the spring of 1842 he took his place again at the Geological Society of London, and gave there some interesting details regarding what he had seen during his absence on the other side of the Atlantic.

About this time (1842) there arose in Canada a desire to know something more about the mineral resources of the colony, and the Legislature went so far as to vote a sum of 1,500*l*. for a geological survey. The Canadian authorities consulted the Home Government as to a suitable person to take charge of the undertaking, mentioning at the same time Mr. Logan's name, and requesting information as to the estimation in which his scientific qualifications were held in this country. Murchison happened at the time to be President of the Geological Society. The official request being forwarded to him, he recommended the proposed appointment in the warmest terms, as one that would "render essential service to Canada, and materially favour the advancement of geological inquiry." This testimony and doubtless the warm support of his old friend, De la Beche, led to Mr. Logan's appointment as organiser and director of the survey of the rocks and minerals of his native country.

From the commencement of this work in 1843 Mr. Logan's whole energies were given to the task which had been assigned to him, and never did a public servant toil more earnestly and disinterestedly for the attainment of the great purpose of his office. He had to struggle on, with little encouragement, in the face of difficulties which only a brave and devoted nature could have faced. First of all, his official position was for many years a most precarious one. Though the Legislature, in a fit of patriotic fervour, had sanctioned the equipment of a geological survey, and had voted a slender sum for its maintenance, yet it soon naturally enough began to ask what value it received for the money thus expended. The Ministers of the day could not always satisfy utilitarian legislators, and indeed Ministers themselves were not infrequently lukewarm friends if not avowed enemies to the young Survey. Mr. Logan's tact in steering his bark through all these obstacles, and finally gaining the haven of popularity both for it and for himself, is above all praise. Yet this was done without the surrender of any of the thoroughly scientific spirit in which his labours were at first conceived. He and his associates worked steadily as true men of science, but they never forgot that in a young country, with resources not only undeveloped but unknown, the exploration of its mineral wealth was a matter of primary importance. Hence year by year, in the reports of progress presented to the Canadian Parliament, he was able to give fresh information regarding commercially important rocks and minerals, while at the same time putting forward facts of the highest interest to students of geology all over the world. It is in these official reports that the chief work of Sir William Logan's life is embodied, including of course the admirable maps on which the field-work has been published.

But his difficulties lay not only in official quarters. He had to go forth into the forest and ascend unvisited rivers without a track or a map. He had to make his own map as he went along, camping out with Indian attendants for months together, and forcing his way as a true pioneer of civilisation, through solitudes which in a few years later were to become scenes of active industry. Through all such hardships he carried a devotion which not only brought him cheerily to the end of them, but inspired his officers with much of his own energy in the common cause. And not his own small staff merely, but farmers, country doctors, and settlers of all kinds whom he enlisted into his service for such work as he found them able and willing to undertake. He used, for instance, to describe graphically and with much quiet humour how in this way he got a number of utterly unscientific colonists to aid in tracing a band of limestone through a district where no rock could be seen for the covering of soil and drift. He provided them each with a long iron-pointed stick and an acid-bottle, and instructed them to thrust the stick well down through the soil till they struck it against the solid rock underneath. Thereupon, pulling it out, they were to apply a drop of acid to the bruised grains of stone adhering to the point of the stick. If they saw a brisk effervescence, they were to mark the place as lying on limestone.

The organisation of the Canadian Geological Survey was admirably adapted for the work to be done, and shows Sir William's skill as an administrator. Directing the whole operations himself, working personally in the field at original observation as well as visiting and superintending the field-work of his staff, he had to get the utmost amount of work done for the smallest amount of money. He secured some excellent assistants in the field-work, whose names have long been familiar to geologists—Alexander Murray, now ably directing the Newfoundland Survey, James Richardson, and, in later years, Robert Bell and others. He early saw that the field-work required to be aided in two important directions—mineralogical and chemical analysis, and palæontological determination. Accordingly, he obtained for the former subject the services of Dr. Sterry Hunt, whose reports on Canadian rocks and minerals and contributions to chemical geology have since become so well known; while for the latter he fortunately found and retained Mr. Billings, who has done such good work among the invertebrate fauna of the older palæozoic rocks of British North America. Ever ready himself to give information and assistance, he everywhere solicited and obtained it from others for the advancement of the Survey.

Of the benefits which the Survey has conferred on Canada, perhaps the best proof is furnished by the firm footing and comparatively liberal equipment which it has now obtained from the Provincial Legislature. The Survey has opened up in a systematic and trustworthy way the mineral structure and resources of the colony. It has formed a museum and laboratory in which the minerals, rocks, and fossils of the country are examined and illustrated with special reference to the industrial development of the country. It has been the means of creating reliable topographical maps over wide regions which had not previously been depicted on any map.

It would take longer to enumerate the many services which Sir William Logan's Survey has rendered to Geology. Foremost among them we should probably place the great additions which it has made to our knowledge of the stratigraphy of the older formations. The existence of the vast Laurentian system with its twofold set of rocks and its Eozoon limestone was a fact first made known by Logan and his associates. The position of the Huronian system was likewise recognised and its name given by them. The northward development of the well-subdivided North American Silurian series with its abundant and characteristic fauna has been most diligently followed out and described by the same band of observers. They have, moreover, given the Survey a European reputation for their chemical and mineralogical work, and for their contributions to our knowledge of some of the older forms of palæozoic life.

These various and admirable labours were in large measure inspired by the genial enthusiasm of the director. The official narrative of them contains the record of the main work of his life. During more than a quarter of a century, while constantly engaged in active and successful exploration, he hardly ever published any papers except in the parliamentary blue-book, in which his annual report was ordered to appear. He seldom came before scientific societies with an account of his discoveries, but cheerfully accepted the more restricted circulation and flimsy appearance of the Yearly Report to the Government. The generalised summary which he published in 1863, in a thick volume, on the progress of the Survey during the first twenty years of its existence, contains the gist of his work, as well as a luminous account of all that was then known of the geology and mineral wealth of the province.

In the year 1856, after his successful representation of the mineral productions of Canada at the Paris Exhibition of 1855, Sir William Logan received the honour of knighthood in recognition of his long and unwearied exertions in the task which he had undertaken. He met with abundant tokens of appreciation from scientific societies both in Europe and in America, and he had the great gratification of seeing that this widespread testimony to the value of his labours and those of his associates was not without its influence upon society in Canada. By impressing his fellow-countrymen with the idea that after all there might be something useful and even to be proud of in their Geological Survey, it probably in no small measure helped to secure the position of the Survey as an institution deserving of support and extension.

In the year 1869 Sir William, finding at last that the duties of his office were becoming too heavy for his advancing years and failing health, resigned his appointment, and was succeeded by Mr. A. R. C. Selwyn, who had served in the Geological Survey of Great Britain, and afterwards directed the Survey of Victoria. His unabated interest in his favourite science, however, was shown by his donation of $20,000 towards the endowment of the Chair of Geology in M'Gill College, Montreal.

Sir William's collected papers and reports would make several stout volumes. They were always written clearly and for the sole purpose of telling what he had seen and believed or inferred. They did not in the least address themselves to the general or popular audience. Indeed, he used to confess himself wholly at sea when called upon to address such an audience, either with the pen or the voice, and gave as an illustration a great meeting convened by his fellow-citizens to welcome him back to Canada after he had been knighted. He was, of course, expected to say something of himself and of his visit to Europe. He tried his best, he said, but soon grasping a long pointer, turned round to some maps and diagrams illustrative of the geology of Canada, and only recovered his peace of mind and command of language when he found himself once more among Laurentian, Huronian, gneiss, limestone, and the rest of his beloved rocks. Nevertheless, he kept copious journals of his various expeditions, and illustrated them with most admirable pen-and-ink sketches. A selection from these could hardly fail to be of great interest, both in relation to the man himself and to the way in which geology has to be carried on amid the wild life of the backwoods.

By those who were privileged with his friendship, Sir William Logan will be affectionately remembered as a frank, earnest, simple-hearted man, ever gentle and helpful, enthusiastically devoted to his profession, and never happier than when discussing geological questions in a *tête-à-tête*, full of quiet humour, too, and showing by many a playful sally in the midst of his more serious talk, the geniality and brightness of his sunny nature. Peace to his memory! He has done a great work in his time, and has left a name and an example to be cherished among the honoured possessions of geology.

ARCH. GEIKIE

TREVANDRUM MAGNETIC OBSERVATIONS

Observations of Magnetic Declination made at Trevandrum and Agustia Malley in the Observatories of his Highness the Maharajah of Travancore, G.C.S.I., in the Years 1852 *to* 1869. Vol. i. Discussed and edited by John Allan Broun, F.R.S., late Director of the Observatories. (London: Henry S. King and Co.)

WE have heard a great deal lately about the native rulers of India, and the worst features of one of them have been brought very prominently before us; but it is a pleasing reflection that they are not all like the potentate of Baroda, while some of them might even read a lesson to the paramount power. Let us hear what Mr. J. Allan Broun, a magnetician of great eminence, has to say of the late ruler of Travancore.

"The Trevandrum Observatory," he tells us, "owed its origin in 1836 to the enlightened views of his Highness Rama Vurmah, the reigning Rajah of Travancore, and to the encouragement given to them by the late General Stuart Fraser, then representing the British Government at Trevandrum. His Highness, desirous that his country should partake with European nations in scientific investigations, sanctioned the construction of an observatory, named Mr. Caldecott its director, and gave him power to furnish it with the best instruments to be obtained in Europe."

The peculiar position of Trevandrum, not far from the magnetic equator, induced Mr. Caldecott, with the Rajah's permission, to procure from Europe a complete equipment of the best instruments for magnetic and meteorological observations, and to build a magnetic observatory, which was completed in 1841.

Mr. Caldecott died at Trevandrum in 1849, and the observatory was in January 1852 placed under the direction of Mr. John Allan Broun, who had previously directed with well-known success the observatory of Sir T. Brisbane at Makerstoun, in Scotland.

Mr. Broun began his office with the conception of an interesting and important problem in terrestrial magnetism, which he was determined as far as possible to work out. This would render it necessary that the observations should not be limited to a single station. He wished, among other things, to determine how far the physical constants of terrestrial magnetism and their various changes depend on differences of height, of latitude, and of longitude.

The Agustia Malley, the highest mountain in the neighbourhood, was chosen as affording the best means for determining the effect of height, and accordingly Mr. Broun resolved to erect an affiliated observatory on this nearly inaccessible rocky peak, surrounded by forests, the inhabitants of which were elephants and tigers. These and all other difficulties connected with this formidable undertaking were, however, completely vanquished, and the Agustia Observatory was completed in 1855.

We learn from Mr. Broun that his labours were not entirely confined to these two observatories. "Other observations," he tells us, especially of magnetic declination, were made simultaneously "during short periods at different stations in Travancore, as nearly as possible on the magnetic equator, 90 miles north of Trevandrum, and also 40 miles to the south. Observations connected with meteorological questions were also made simultaneously to the east and west, and about 5,000 feet below the Agustia peak, on the peak itself, and at Trevandrum; while on one occasion hourly observations were made during a month at five different stations, varying gradually in height from the Trevandrum Observatory (200 feet) to 6,200 feet above the sea-level, in which fifteen observers were employed."

In this first volume Mr. Broun has confined himself to the magnetic declination, and one of the chief objects sought has been to determine every possible action of the sun and moon upon the magnetic needle. The observations extend from 1852 to 1870, and embrace in all nearly *three hundred and forty thousand readings.*

A considerable portion of the introduction is devoted to the discussion of a question which has, we think, been somewhat too much overlooked. When a magnet is suspended by a thread and enclosed in an appropriate box, it does not necessarily follow that all its movements are due to magnetic causes, for changes in temperature and humidity may affect the zero of torsion of the thread, and thus cause slight changes in the position of the suspended magnet. It is perhaps unlikely that such changes could seriously affect the character of the daily variation, but it has been thought that they might perceptibly affect the annual variation, since in this case the magnetic change is comparatively small, while the range of temperature and humidity is generally great.

Mr. Broun overcame this source of error by observations of an unmagnetic brass bar suspended in the same way as the magnet, which thus afforded him the means of estimating, and hence eliminating, the error due to these causes.

Besides all this, several declinometers were used and compared together, and the result of all these comparisons tends to impress the reader with the fact that we have in this volume a series of observations of the magnetic declination of a thoroughly accurate and trustworthy nature.

The following passage from Mr. Broun's magnetic diary may be quoted as exhibiting the sources of error to which magneticians are exposed, as well as the care bestowed in avoiding them—

> "1855, Dec. 4d. 9h. A sudden vibration of Grubb's magnet through thirty scale divisions was observed, and the difference of Adie's and Grubb's instruments, which had previously been − 0′·05, became suddenly + 3′·50. It was supposed that either the suspension thread was breaking, or that a spider had got within the box.
>
> "Dec. 4d. 22h. The boxes were removed, and an exceedingly small spider was discovered and removed. This was the only occasion in which a spider succeeded in entering Grubb's declinometer boxes between 1852 and 1870. Every care was taken when the boxes were removed, before replacing them, to hold them for some time over the flame of a lamp, so that spiders, even invisible to the naked eye, must have been dislodged or destroyed."

It remains now to give our readers a summary of the most important results obtained by Mr. Broun from the reduction of his observations.

In the first place, the *secular variation* is found to be irregular, but the observations seem to indicate that after a certain interval the acceleration or retardation of the secular movement has equal values. *This interval is estimated at* 10·5 *years.* In order to find the *annual period*, the variations which form the secular and decennial inequalities have been eliminated. The observations then indicate a twofold inequality, one of which corresponds to a single oscillation in a year, with a minimum in March or April, and a maximum in September or October, while the other represents a double or semi-annual oscillation with maxima in March and September.

Mr. Broun was also led to suspect a *period of forty-four months*, which was repeated four times successively in his observations, although no cause is known which could produce an inequality of this duration.

The next inequality noticed is *the twenty-six day period*, which Mr. Broun is inclined to attribute to solar action with more confidence than the longer period of ten or eleven years. Our readers will remember that the period was re-discovered by Dr. Hornstein, director of the Prague Observatory. Mr. Broun thinks that there are traces of a double oscillation of the twenty-six day period.

Coming next to the important *solar diurnal variation*, the chief features of which are tolerably well known, Mr. Broun finds this to consist of one marked maximum and one marked minimum of easterly declination in each month of the year, and of one or more secondary maxima and minima.

The principal maximum occurs in the six months of April to September at about 7 A.M., and the principal minimum about twenty minutes past noon in the same months. Nearly the inverse of this happens in the four months of November to February. The results obtained by Mr. Broun appear to him to indicate the action of opposite forces belonging to the two hemispheres, which mainly destroy each other in March and October at Trevandrum, but one of which is preponderant in the other months of the year; and of these forces he remarks that those of the northern hemisphere seem to have a greater effect on the variations of the whole globe than those of the southern hemisphere.

The daily range was a minimum in 1856 and a maximum in 1860. It is a minimum in March and October, and a maximum in August and December.

In considering the *lunar diurnal variation*, Mr. Broun begins by showing that the results relating to the variation to be obtained by him are really due to the lunar action, and not to any portion of solar perturbation remaining uneliminated.

The following very singular results have been obtained :—

1. The mean lunar diurnal variation consists of a double maximum and minimum of easterly declination in each month of the year.
2. In December and January the maxima occur near the times of the moon's passages of the upper and lower meridians ; while in June they happen six hours later, the minima of easterly declinations thus occurring near the times of the two passages of the meridian.
3. The mean of the ranges of the lunar diurnal variation shows (like the solar diurnal range) a minimum in 1856 and a maximum in 1860.
4. The action of the moon on the declination needle is greater in every month of the year during the day than during the night.
5. There appears to be a remarkable change in the lunar action connected with the rising and setting of the sun, especially with the former.

We now come to a part of the reductions where we feel compelled to differ from the eminent magnetician as to what may be termed the scientific policy which he has pursued. We allude to the question of disturbances.

There can, of course, be no doubt that a strictly mathematical discussion of a series of observations will indicate the various periods of action of the influential forces. We know that this method served to indicate many important astronomical periods long before the mechanical nature of the astronomical forces was recognised.

We might, for instance, take a body of meteorological observations and treat them in a strictly mathematical manner, and we should no doubt be led to a yearly and to a daily period, even if we were not acquainted with the existence of the sun. But who would pursue this method? We take advantage of the knowledge derived from other sources of the exact length of these two periods to begin with, and do not think of endeavouring to obtain these by means of the observations themselves.

Furthermore, in meteorology, with the general consent of all engaged in it, we have gone even further than this. There is unquestionably a distinct daily and yearly fluctuation of the meteorological elements brought about by the sun, but besides this there are other phenomena ultimately due to the sun, though not in the same way, which meteorologists have agreed to consider apart by themselves.

We allude to cyclones, which, when examined separately, are found to obey very different laws from those which regulate ordinary atmospheric changes. Thus these laws have been discovered by agreeing to separate certain observations which were unmistakably abnormal, and to discuss those by themselves, and the result has been the most interesting and important discovery of the law of storms. And if it be asked what right meteorologists had to separate a body of disturbed observations, the reply will obviously be that they are justified by their success. Deny the right, and a cyclone becomes an altogether false and illegitimate scientific conception.

Now, a large and increasing number of magneticians are of opinion that the phenomena of terrestrial magnetism can bear a similar treatment. They believe that the sun has a daily and yearly influence on the magnetism of the earth just as it has upon its meteorology, and they also believe that it is the cause—the indirect cause, it may be—of an abnormal magnetic influence, just as in meteorology it is the indirect cause of the cyclone. Some even go so far as to say that these two abnormal influences, the one in magnetism, the other in meteorology, are intimately connected together. This assertion, however, is not now the point in question. The point is that we have in magnetism certain abnormal disturbances which may be compared to abnormal meteorological disturbances. Now, it is held by Sir E. Sabine and those who share his views, that it is expedient to separate out these disturbed magnetical observations, just as we separate out the meteorology of a cyclone. This school assert that we may thus arrive at a series of phenomena obeying very different laws from those of the undisturbed observations, and that we are therefore justified in making the separation, inasmuch as we are thereby led to a clearer knowledge of the various ways in which the sun affects the magnetism of the earth. And they insist very strongly upon the point that both these magnetic actions of the sun have diurnal and annual variations different from one another, so that if treated together we obtain a result much more complex than if they be treated separately.

We have little doubt of the policy of this method of treatment, and we cannot, therefore, but regard it as a misfortune that Mr. Broun has not unmistakably adopted it. He has, however, given us all the individual observations, so that, if it be thought desirable, those magneticians who advocate a somewhat different method of reduction may make it for themselves. We need only add, in conclusion, that the appendices will be found to be very interesting reading, and that all who are interested in terrestrial physics must look with great interest to that magnificent series of researches of which the volume before us forms the first instalment.

B. STEWART

OUR BOOK SHELF

Chapters on Sound, for Beginners. By C. A. Martineau. (London: The Sunday School Association; Manchester: Johnson and Rawson, 1875.)

WE have read this little book with great pleasure. Its object, the author tells us, is to teach a few of the simpler facts in acoustics in such a way that the learner shall not be deterred by unnecessary difficulties, either in the use of technical language or in having to provide expensive apparatus. Most successfully has the author attained the end he had in view. It is just what a child's book on science should be. Written in a simple attractive manner, without any silly childishness, it conveys a great deal of information, and that in the best kind of way. For the learner, by a series of simple experiments, is made to lay firmly the groundwork of his knowledge on this subject. All the apparatus the author requires is a toy fiddle, one or two small tuning-forks, a couple of finger-glasses, a clamp, a square and a round piece of glass, a gimlet, a tall jar, silk thread, and some solitaire balls. With such homely instruments really good elementary teaching is given. The chapter on strings made to vibrate in time with tuning-forks is capitally done, and will give the learner more knowledge than he could gain from many a pretentious text-book. We should like to suggest to the author a few additions to his simple experiments, but in the limits of this notice we cannot do more than direct his attention to the Instructions in practical physics given to the science teachers at South Kensington, and printed for their use by the Science and Art Department. There is of course nothing new in the way of experimental illustration in these chapters on sound; it is the good use the author has made of what has been done by others that is the merit of this little book. We gladly recommend it to all girls and boys who will honestly go through what is to be done as well as what is to be read.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts, No notice is taken of anonymous communications.*]

On the Temperature of the Human Body during Mountain Climbing

THE account of Dr. Forel's laborious and carefully conducted observations on the temperature of the body during mountain climbing, given in NATURE, vol. xii. p. 132, has recalled to mind the results of a few observations which I made shortly after the publication of Dr. Lortet's and Dr. Marcet's experiments. As my results are in the main confirmatory of those of Dr. Forel, they may not be without interest as a contribution to what, until the appearance of Dr. Forel's memoirs, was regarded as the heterodox side of the question.

Before joining the party of observers sent out to Sicily to see the solar eclipse of 1870, I provided myself with a set of delicate clinical thermometers with a view of repeating the observations of Drs. Marcet and Lortet, should any opportunity occur of getting up Etna during our stay in the island. On Christmas-day a number of us attempted to make our way up the mountain, and with the aid of Mr. Fryer I made a number of observations of body-temperature on myself during the ascent. The temperature of the mouth was taken, as in the observations of Marcet and Lortet. The thermometer employed was carefully selected so as to get the maximum amount of displacement in the column for a thermal disturbance with a minimum bulb-capacity. As regards sensitiveness, it left little to be desired. Some weeks before the start a number of preliminary observations were made with the view of ascertaining the best manner of placing the thermometer and of determining the length of time required for the column to attain a position of rest. By repeated trials it was found that fully five minutes were needed after placing the thermometer in position before the level of the mercury became approximately constant, both during repose and after a rapid run. Any subsequent variation seldom exceeded $\frac{1}{20}$ of a degree F. The following readings taken from among a number of similar observations will serve to show the extent of the changes from minute to minute after placing the thermometer *in situ*:—Time, 7·30 P.M.; condition, rest. After first minute: Temp., 96°·4; second, 97°·9; third, 98°·4; fourth, 98°·5; fifth, 98°·5. That there is nothing in the rate of change peculiar to the individual is evident from the results of a similar series made at the same time upon another person: first minute, 96°·4; second, 97°·0; third, 97·5; fourth, 97°·8; fifth, 97°·8.

On the day of the attempted ascent we set out from Catania at 5·30 A.M., and drove to Zaffarana. Mouth-temperature before starting, 98°·4. In the carriage, 98°·3; time, 9h. 10m.; pulse, 78. At Zaffarana, 98°·4; pulse, 83. As Zaffarana lies at a considerable elevation above the sea-level, the observations so far serve to confirm Dr. Marcet's statement that the rarefaction of the air is without influence on the temperature of the body. After a stiff walk of thirty-five minutes, during which the aneroid fell 0·49 inch, the temperature was again found to be 98°·3; pulse, 116; time, 10h. 42m. Twenty-three minutes later, after rapid walking (barometer 0·48 inch lower than previous reading) the observations were: First minute, 96°·3; second, 97°·4; third, 97°·6; fourth, 97°·7; fifth, 97°·8; pulse, 116. At 12h. 4m., after continuous walking at a good speed, the observations were: First minute, 94°·2; second, 96°·2; third, 97°·4; fourth, 97°·8; fifth, 98°·1; pulse, 128. The pace was now quickened almost to exhaustion, and at 2·30 P.M., when greatly fatigued, the observations were: First minute, 93°·9; second, 95°·6; third, 96°·8; fourth, 97°·4; fifth, 98°·0; pulse, 90. These last observations were made with some difficulty, and under such circumstances that I am disposed to attach less weight to them than to the former readings. My exhaustion was doubtless partly due to hunger, for I purposely fasted in order to test the correctness of Lortet's statement that the fall in temperature is specially marked during an ascent made when hungry.

These observations were all I could obtain, as I was too much fatigued to carry on the work. They are scarcely numerous enough to enable any very definite conclusions to be drawn; but so far as they go, they certainly are not confirmatory of the conclusions arrived at by Drs. Marcet and Lortet; they at least prove that if any decrement does occur during climbing, it is never so great as 8° (Lortet), or even as much as 3° (Marcet).

It may be thought that the low readings obtained in the later observations on first placing the thermometer in the mouth, are indicative of a decrease in body-temperature. It must be borne in mind, however, that, especially in the later observations, we were facing a keen wind sweeping down a mountain partially covered with snow; it is perfectly obvious from this cause that the first minute's observations can afford no reliable indication of the temperature of the mouth, or otherwise the body must recover its normal temperature with a rapidity which would be perfectly extraordinary. From repeated trials made on myself and others, I have come to the conclusion that observations of the temperature of the mouth taken even after the end of the second minute give no trustworthy indication of the temperature of the body; such indications are of no value even as comparative measurements.

As it seems quite certain that any variation which may occur is a matter of tenths and not of whole degrees, it may be well to point out a source of error in the method of observation which seems to have escaped the attention of observers hitherto, but which in any case is too considerable to be neglected, although it would specially affect the results obtained at high altitudes. In taking the temperature of the mouth on a mountain, surrounded by a rapidly moving atmosphere at a temperature often but little higher than that of melting snow, it is obvious that the mean temperature of the mercurial column must be considerably lower than that of the mouth, since the greater portion of the stem is in the cold air. The correction to be added to the readings is readily calculated if we know the length of the exposed column, its mean temperature, and the apparent expansion of mercury in glass. If we suppose the length of the exposed column in the observation taken at 2.30 P.M. to be forty times the length of a degree, and its mean temperature that of melting snow, the correction to be added to the last reading would amount to a quarter of a degree.

The whole subject unquestionably merits reinvestigation. A much larger number of observations is needed; these should be made under similar circumstances on different persons, for it may well happen that the bodily idiosyncrasy of the individual may affect the result. Possibly some Alpine party may undertake the solution of the problem during the present season. It is doubtless not so simple as it may at first sight appear. From my experience during the ascent of Etna, and from what I have been able to glean of the manner in which other observations have been made, it seems clear that the conditions necessary to obtain perfectly comparable results have yet to be determined. Should any variation be observed, either in the direction observed by Drs. Marcet and Lortet or in that indicated by the experiments of Dr. Forel, it would be specially interesting to determine how quickly the human body recovered its normal temperature on resting.

T. E. THORPE

Arctic Marine Vegetation

IN NATURE, vol. xii. p. 55, an interesting article on the Arctic marine vegetation, quotes Ruprecht (with doubt as to his accuracy) in regard to an asserted absence of Algæ in Behring Sea and the waters north of it.

That doubt is well founded, as I can testify, having been engaged during a large part of ten years in explorations of that region. The line of the Aleutian Islands from east to west is girt with seaweeds, which are quite as abundant on the north as on the south side of this archipelago. If Ruprecht, however, referred to the waters still further north, he is equally in error. Unfortunately I am not possessed of much more botanical knowledge than comes from collecting for my botanical friends, and to them I must leave the task of enumerating the species, but perhaps a few remarks on the general distribution of the Algæ of this region may not be without interest. It is noteworthy that fine and beautiful seaweeds, such as are used for ornamental albums, are comparatively quite rare on the whole coast, from the Vancouver Archipelago north and west. Rhodosperms are particularly scarce in individuals, though how far this may be true of species I am not competent to say. Chlorosperms are confined to a very small number of forms, also rare as individuals. The great mass of the algoid vegetation of this region is made up of Melanospermæ.

Some forms which I believe are closely related to if not identical with *Fucus vesiculosus*, are found in masses on the rocky shores of Behring Sea, from the Aleutian Islands north to Behring Strait, and I do not know how far beyond.

The distribution of the Algæ seems to be largely dependent upon the character of the rocks. Basaltic shores are least rich and afford few forms, except what I have called *F. vesiculosus*, and species of *Agarum*. Granitoid rocks and Tertiary sandstones and conglomerates always afford at least a few forms of red and green seaweeds, while on the metamorphic slates and porphyritic rocks, which make up the greater part of the Aleutian chain, the *Nereocystis*, *Laminaria*, *Nullipores*, and *Agarum* seem to find their most congenial home. The character of Behring Sea is unfavourable for the growth of seaweeds. Much of the eastern plateau is of soft sticky mud or fine clean black volcanic sand, affording no hold for Algæ. But wherever there are rocks Algæ may be found, though the more delicate kinds are always rare. Jointed and incrusting stony Algæ are abundant on most of the Aleutians, and I have noticed them also at the Pribiloff group, Nunivak, Norton Sound, and Plover Bay in East Siberia, though less common northward.

The "bull-head kelp" (Nereocystis?) is excessively abundant in the Aleutians, and extends north to Nunivak and the Pribiloff Islands. There is a patch of twenty-five square miles in extent, north-east of St. George Island, on a shoal in the open sea. I do not recollect its occurrence further north than Nunivak. *Laminaria* extends to the Straits, and possibly north of them, with *Agarum*, the two most abundant seaweeds of Behring Sea. *F. vesiculosus* everywhere where there are rocks; also a flat, leathery, thick-fronded alga with short stalks, which the sailors call "devil's aprons." These have the edges variously cut or indented, though some forms are oval, with two thickened marginal bands extending outward from the stalk. In Norton Sound, in 1865–66 and 1867, I obtained what seemed to me to be at least fifteen or twenty species of algæ, which included something that I could not distinguish from the "Iceland moss" of the coasts of New England, and which was not found further south. In many places where the bottom was unfavourable for algæ I have found dead shells and living crustacea entirely hidden under a growth of red and green algæ, which, without exercising great care, would often have led to the rejection of valuable specimens of invertebrates from the dredge, from their being taken for mere bundles of seaweed.

I may also mention that in the hot springs (110°–180° F.) which exist on the peninsula of Alaska and many of the islands, there is invariably a leathery brown algoid, covering the bottom of the basins in which the springs occur. *Nostoc* also flourishes in the fresh waters emptying into Norton Sound. I have many times noticed the *F. vesiculosus* apparently flourishing in lagoons where the water was barely brackish to the taste, and to which the sea had no access except in extraordinary storms such as might occur once or twice in a year.

Much of the above may be without interest to the scientific botanist; I leave it to your judgment what to reject, but I think that there is no further necessity for disproving the error into which Ruprecht has in some way been led; certainly, if he had himself walked the beaches of Behring Sea, where any rocks exist, he could not have come to such a conclusion.

WM. H. DALL

Smithsonian Institution, Washington, D.C., U.S., June 10

South American Earthquakes

ON the 18th May, that is, the same day that, if the telegraphic news be correct, the cities of Cucuta, Santiago, and others were destroyed by an earthquake, a distinct and prolonged shock, preceded and accompanied by a loud rumbling noise, awoke the greater number of the inhabitants of this place, about a quarter of an hour before midnight. The direction of the phenomenon was thought by some who heard and felt it to be from east to west; but this opinion was, I have reason to believe, inaccurate.

Not knowing as yet the exact time at which the Columbian disaster took place, I am unable to calculate the rate at which the shock, connected with, one can hardly doubt, the great earthquake above alluded to, may have travelled the long distance that separates St. Thomas from Cucuta. Fuller details may subsequently, I hope, help to elucidate the matter.

It is worthy of note that whereas before the 18th May an unusually long period had elapsed during which no subterraneous vibrations had been felt in this island, there have occurred since that date several slight shocks at various hours of the day and night, with a frequency above the average.

St. Thomas, West Indies W. G. PALGRAVE

Glacier and other Ice

THE reviewer of Croll's "Climate and Time" in NATURE of the 24th June (p. 144) says: "What is there in this (Mr. Croll's) theory to distinguish a glacier from a common piece of ice? which on this principle ought to flatten out and not retain its shape as it does."

I believe that, independently of any theory of the cause of glacier motion, there is no physical difference whatever between glacier and other ice. The greater mobility of a glacier is merely due to its greater size and weight; just as water in a river-bed flows with very little friction, under a pressure that would not make it flow at all in a capillary tube. The plasticity of ice may however be shown on a small scale. I have read somewhere that a slab of ice supported only on its two ends will gradually bend down in the middle: and I have seen Prof. James Thomson at the Belfast Museum illustrate a lecture by moulding a few lumps of ice by pressure into the shape of a cup.

I am not writing in defence of Mr. Croll's theory of glacier motion. I believe the best explanation of those physical properties of ice on which glacier-motion depends is that given by Prof. James Thomson. I know Mr. Croll's theory only from your review, and I do not know how far it agrees with Prof. Thomson's. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, June 26

The House-fly

I AM disappointed to find that no one has answered "Harrovian's" query in vol. xii. p. 126, as to the mortality amongst the house-fly, and the yellow powder which covered the carcase. I have noticed myself that house-flies often die in numerous company. I had an idea that it was owing to the temperature falling to its benumbing point, until I found the same thing happening while the thermometer was particularly high. Then I thought that all these dead flies might belong to the same brood, and having lived under almost exactly the same circumstances, their threads of life were spun out at almost exactly the same time. This new theory, again, did not stand examination well under the microscope. But the result of my experiment differed slightly from that of "Harrovian." At least I find I entered in my notes, "the body covered with white eruption, apparently a disease of the skin."

Denstone College, Uttoxeter D. EDWARDES

OUR ASTRONOMICAL COLUMN

AN ANCIENT "URANOMETRIA."—We have received a very interesting work, published by Dr. Schjellerup, of the Observatory of Copenhagen, under the auspices of the Imperial Academy of Sciences of St. Petersburg. It contains a description of the constellations, with the star magnitudes, composed in the middle of the tenth century by the Persian astronomer, Abd-al-Rahman al-Sûfi, and is a literal translation of two Arabic manuscripts preserved in the Royal and Imperial libraries of Copenhagen and St. Petersburg. A more particular account of the valuable addition which Dr. Schjellerup has made to the literature of astronomy will be given in this column next week. Meanwhile, we may just note one curious statement made by the Persian astronomer with reference to the well-known variable star Algol, viz., that at the time of his observations the star was *reddish*—a characteristic applied also to Antares, Aldebaran, α Hydræ, and a few other stars, which are also reddish in our own day; but at present there is no tinge of colour about Algol, which may be fairly described as a white star, and if there be one of its class more than another in which the periodical fluctuation of light can with much appearance of probability be attributed to the intervention of a revolving attendant, passing regularly in our line of sight, it is to this star that we might point in illustration. Its former ruddy light, however, rather necessitates a different explanation, and one which, notwithstanding the comparative regularity of its changes, may perhaps assimilate it to the more numerous class of variable stars.

THE "BLACK SATURDAY" ECLIPSE, 1598, MARCH 7.—This eclipse, which was visible in its total phase in Scotland, like that of 1652, April 8, noticed in this column last week, was remembered long afterwards in that country, the day of its occurrence being called "Black Saturday." The elements were very approximately as follows:—

Conjunction in R.A. 1598, March 6, at 23h. 1m. 38s. G.M.T.

	°	′	″	
R.A.	347	44	8	
Moon's hourly motion in R.A.		32	9	
Sun's " "		2	18	
Moon's declination	4	16	1	S.
Sun's "	5	16	33	S.
Moon's hourly motion in Decl.		17	8	N.
Sun's " "		0	59	N.
Moon's horizontal parallax		59	51	
Sun's "			9	
Moon's true semidiameter		16	19	
Sun's "		16	5	

The sidereal time at Greenwich noon on March 7 was 22h. 59m. 34s., the equation of time 11m. 33s. subtractive from mean time, and the middle of general eclipse at 22h. 10m. 29s.

Hence the following points upon the central track of the shadow:—

Long. 6° 21′ W., Lat. 51° 15′ N.	Long. 3° 14′ W., Lat. 55° 48′ N.
" 4 17 " 54 12	" 1 55 E. " 64 29
" 3 45 " 54 59	" 5 27 E. " 71 37

The semi-diameter of the belt of totality appears to have been about forty-five miles only. This belt included Edinburgh, where the total eclipse commenced about 10h. 15m. 36s. A.M. on March 7, local mean time, and continued 1m. 29s. with the sun at an altitude of 26°. At Douglas, Isle of Man, the eclipse was also total for about the same interval, the sun disappearing at 10h. 6m. 43s. A.M. local time according to the above elements.

The date for this eclipse is given for *new style*, as was also that for the eclipse of 1652.

While referring to this subject we may mention that Dr. Celoria, of the Observatory of Milan, has calculated the circumstances of the total solar eclipse of 1239, June 3, from the tables of Hansen—with Leverrier for sun. Prof. Schiaparelli had collected together a large number of notices of the totality of this eclipse in its passage across Italy, his authorities being chiefly found in the great work of Muratori. It appears to have been total (if we may assume totality from the visibility of stars and the night-like appearance of nature) at Monpellieri, Mirabeau (where Zach found an inscription referring to the phenomenon), Digne, Alessandria, Genoa, Piacenza, Parma, Lucca, Modena, Florence, Siena, Arezzo, Este, Ravenna, Lesina on the Adriatic, &c.; but Hansen's tables, according to the calculations of Celoria, do not include the greater number of places within the belt of totality. It may be remembered that a calculation of the eclipse which occurred only two years later (1241 October), published by Hansen in the Transactions of the Saxon Society of Sciences, gave a total eclipse both at Erfurt and Stade near Bremen, where it is recorded to have been so observed, and hence his tables were considered satisfactory. Both eclipses may deserve further examination.

D'ARREST'S COMET.—This comet appears now to make a very close approach to the orbit of the planet Jupiter, from which circumstance it is possible that in some forty-five years from this time its elements may be entirely changed. Considerable perturbations from the attraction of this planet took place between the latter part of the year 1857 and the next period of the comet's visibility, so that by Leveau's calculations for that epoch the time of revolution had been increased sixty-eight days, the inclination diminished more than two degrees, with very material changes in the other elements. If we adopt the orbit found by Leveau for the last appearance, we have the following distances of the comet from the orbit of Jupiter at different points of heliocentric ecliptical longitude—equinox of 1872:—

In 139° 1′	distance	0·411	...Aphelion
146 28	,,	0·292	...Ascending Node
150 0	,,	0·189	
152 0	,,	0·098	
153 0	,,	0·085	

In longitude 153° 10′, which is about the point of nearest approach, the distance between the two orbits is only 0·0841. At this point the comet's radius-vector is 5·4254, with latitude 1° 52′ N., and it is passed 873 days or 2·39 years before the arrival at perihelion. Without very sensible perturbations in the mean time, the comet and planet would encounter each other at the latter end of the year 1920, when, as noted above, an entire change of orbit might take place.

THE MINOR PLANETS.—Inquiries are occasionally received for the fullest catalogue of elements of the minor planets. Such readers as have occasion to refer to a pretty complete list, will find the latest and most authentic summary in the "Berliner Astronomisches Jahrbuch" for 1877, where the orbits of upwards of 130 of these planets are given, and in many cases from new and complete discussion. Indeed, the preparation of elements and ephemerides of the minor planets forms a speciality of the "Berliner Jahrbuch" under the superintendence of Prof. Tietjen. The labour and practical difficulty attending this work have now become very great, so much so as to require almost exclusive devotion to it of a body of computers, if accurate results for the guidance of observers are expected. Prof. Tietjen to a considerable extent ensures this. The elements are collected by him in each successive volume, the latest being found as stated above in that for 1877, published within the last few months.

ON THE PLAGIOGRAPH *aliter* THE SKEW PANTIGRAPH

I HAVE been led by the study of linkages to the conception of a new instrument, or rather a simple modification of an old and familiar one, the Pantigraph, by means of which a figure in the act of being magnified or reduced may at the same time be slewed round the centre of similitude. Some of the readers of NATURE, such possibly as my able and most ingenious friends, Messrs. George Cayley and Francis Galton, may be able to pronounce with authority how far the invention is new and whether it is likely to be found in any way useful in practice as applied to the art of the designer or engine turner. Already my invention of the Isagoniostat, or equal angle setter, which I shall take some other opportunity to communicate to this journal, has been deemed available in practice for working automatically the train of prisms of a spectroscope.

In Fig. 1, A O B C Q represents an ordinary pantigraph. O is the fixed point, P is the tracer, and Q the corresponding follower; then, as everybody knows, any curve traced out by P will be imitated by Q, and the two curves will be similarly situated in respect to O. The point of addition is the following:—

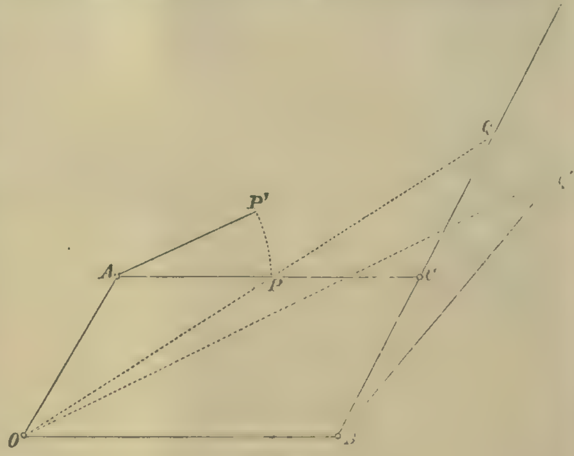

FIG. 1.

Let P be moved through any angle, P′ A P round A, and Q through *an equal angle* Q B Q′ in the *opposite* direction round B, and let P′ and Q′ be supposed to be in any manner rigidly connected with the bars A C, B C respectively. Then it admits of an easy proof that in whatever way the pointed parallelogram A O B C is deformed, O Q′ will bear to O P′ the constant ratio of A C to A P, and moreover the angle P′ O Q′ will always remain equal to the angles P′ A P, Q B Q.

It follows that whilst P′ is made to move upon any curve the follower Q′ will trace out a similar curve altered in magnitude, and at the same time turned round the first point O.

If, as in Fig. 2, we take A D equal to A C, B E equal to B C, and the angles C A D, C B E equal to each other, then the rays O D, O E will always remain equal and be inclined to each other at a constant angle. With this adjustment the instrument may be used to transfer a figure from one position in a sheet of drawing paper to any other position upon it, leaving its form and magnitude unaltered, but its position slewed round through any desired angle.

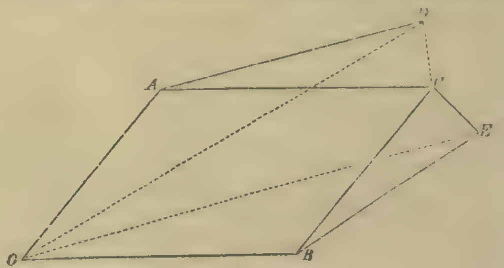

FIG. 2.

J. J. SYLVESTER

SCIENCE IN GERMANY

(*From a German Correspondent.*)

WHEN in 1819 Dulong and Petit measured the specific heats of some solid elements they found for each of the elements experimented upon, a very simple relation between its specific heat and its atomic weight: the product obtained by multiplying the specific heat with the atomic weight gave a constant value, or, in other words, the atoms of all the elements experimented with have the same capacity for heat. The investigation of Regnault confirmed this law, showing that it is valid for most of the solid elements with tolerable exactness; but it should be remembered here that the specific heats of these elements must be determined at temperatures which are sufficiently below the melting points of the elements in question. Only carbon, boron, and silicon proved exceptions to this remarkably simple, natural law; for these three elements far smaller atomic heats were found. It was also found that the different allotropic modifications of these three elements possess quite different specific heats, and that none of these specific heats were in accordance with Dulong and Petit's law. Later on similar results were obtained by De la Rive and Marcet, Wüllner and Bettendorf. We must not forget to mention, for the sake of completeness, that with regard to the difference in the specific heats of the allotropic modifications of an element, Kopp has already, in 1864, stated his belief that all allotropic modifications of each element possess the same specific heat in all cases, and that the results of experiments which are contradictory to this view must be considered as caused either by a faulty method of observation or else by impurities in the substances used.

Herr Weber of Hohenheim has succeeded lately in proving the validity of Dulong-Petit's law, also for carbon, boron, and silicon; his experiments were made with Bunsen's ice-calorimeter. In order to heat the substances experimented upon to a series of temperatures below red heat, oil baths were used, and various temperatures between 0° and 300° C. were applied; in order to cool them, solid carbonic acid and a cold mixture, consisting of one part of snow and $\frac{1}{2}$ part of common salt, were employed. All these temperatures were read off directly from an ordinary air-thermometer. For higher temperatures (between 500° and 1000°) an indirect method was made use of, which allowed of the determination of the temperatures by means of the indications of the calorimeter. This indirect method is based on the correctness of Pouillet's determinations (published in 1836) of the quantity of heat which a certain unity of weight of platinum requires to become heated from temperature T_0 to T. (These determinations are given by Pouillet for the interval $T = 0°$ to $T = 1200°$ C.) The results which Herr Weber obtained may be stated as follows:—The specific heats of carbon, boron, and silicon increase regularly as the temperature rises, from the lowest obtainable degrees of temperatures upwards, and finally remain nearly constant after a certain degree has been reached. The nature of the function, which expresses the dependence of the specified heat γ from the temperature T, seems to be the same for all the three elements, and to possess the following formula:—

$$\gamma = A - \frac{B(1 + hT)}{e^{qT}}$$

where A, B, q and h express constant positive values, and $A > B$, $q > h$, and also T is the temperature counted upwards from the absolute zero.

The temperature from which the specific heat of carbon remains nearly constant is somewhere near 600° C., and it is immaterial whether the carbon is in the form of diamond or in that of graphite. From red heat upwards this element shows no greater variability in its specific heat than the other elements which follow Dulong-Petit's law. (At lower temperatures, however, for instance when the temperature rises from − 50° C. to + 600°, its specific heat increases sevenfold). The specific heats of graphite and diamond are perfectly identical above 600° C., if we neglect small differences, which do not exceed the numerical value of the specific heat by more than 0·5 to 2 per cent. The specific heats of graphite, of the dense amorphous coal, and of the porous charcoal, are within the interval from 0° to 225° C. perfectly identical from degree to degree. Thus all opaque modifications of carbon (the graphitic, dense and porous forms) have the same specific heat. We may say that below red heat, from a *thermal* point of view, there are only two different allotropic modifications of carbon, the transparent and the opaque one. The specific heats of these modifications differ all the more the lower their respective temperatures; if the latter rise, they approach each other steadily and become identical at about 600°. Above red heat there are no different allotropic modifications of carbon with regard to specific heat; from that point in the scale of temperature, where the *optical* difference of the two modifications of carbon ceases, the *thermal* difference ceases also. Kopp's view as quoted above is thus completely affirmed.

With regard to the specific heat of crystallised silicon, it approaches (analogous to the specific heat of carbon) as the temperature rises a nearly constant limit, which is reached at about 200°, after having passed through highly variable values. At that point of the scale of temperature the variability of the specific heat of silicon is no greater, than that of the metallic elements. With regard to the experiments with crystallised boron, it has been found that within the interval of temperature from − 80° to + 260° C. the specific of this element behaves in a manner which is perfectly analogous to the specific heats of opaque and transparent modifications of carbon. This great coincidence in the behaviour of the specfic heats of both elements justifies the supposition that also the specific heat of boron in a rising temperature approaches a nearly constant limit, and that this lies somewhere near a moderate red heat. Unfortunately, Herr Weber could not prove the correctness of this supposition by direct experiments through want of sufficient material.

The nearly constant final values, which are reached as the temperature rises by the specific heats of both carbon and crystallised silicon, were found to be, in round numbers—

For carbon … … … … … … …	0·46
„ crystallised silicon … … …	0·205

For crystallised boron, as we have said before, this final value could not be experimentally determined, but from the measurements that were made, and from the nature of the function which represents the specific heat of boron in its dependence upon temperature, we may conclude that this final value lies somewhere near 0·5. The atomic weights of the three elements, as found by the determination of their vapour densities, are—

Carbon … … … … … … … …	12
Silicon … … … … … … … …	28
Boron … … … … … … … …	11

The products of these figures when multiplied by the specific heats of these elements as mentioned above, give for their atomic heats the values—

5·5 … … … 5·8 … … … 5·5

i.e., values which closely correspond to the atomic heats of metals and the other solid metalloids.

Hence it follows that beyond a certain temperature, carbon, silicon, and boron also follow Dulong and Petit's law, and continue to do so as long as the temperature rises. Dulong and Petit's law has thus become one without exceptions. The wording of this law ought, however, to be somewhat different to what it has been up till now; the following would, perhaps, be best:—

"The specific heats of the solid elements vary acording to temperature; but for each element there is a point T_0 in the scale of temperature beyond which, as the temperature T rises, the variability of the specific heat becomes insignificant. The product obtained by multiplication of the atomic weight with that value of the specific heat which belongs to the temperatures $T > T_0$, is a nearly constant value for all solid elements, and lies between 5·5 and 6·5."

S. W.

*MAGNETO-ELECTRIC MACHINES**

III.

FROM this property of the Gramme machine it may be employed to measure by the method of opposing currents any electromotive force. For this purpose it is only necessary to ascertain the velocity of rotation of the ring when the equilibrium between the currents is established. This may be measured in one of two ways—by the velocimeter of Deschiens, or by a chromoscopic diapason. The mode of operating with the latter when applied to the Gramme machine is thus described in M. Breguet's work. On the axis of the ring is mounted a small plate whose plane surface is covered with lamp-black by holding it over a candle. A tuning-fork vibrating one hundred times in a second, and carrying at one end a little style, is held in the hand, or, still better, fixed on a special support. At the precise moment that the two electromotive forces are shown by the galvanometer to be equal, the style is brought into contact with the blackened surface of the plate, upon which it traces a sinuous line. A very short contact is sufficient to give the required result. On stopping the machine, it will be seen to what fraction of the circumference ten sinuosities of the line traced on the plate correspond, from which it may be inferred in how many hundredths of a second the entire revolution of the ring has been accomplished. It is stated that if the ring in the Gramme machine be turned at a perfectly steady rate, the current produced will be more rigorously constant even than that of a Daniell's battery in good working order. Fig. 7 represents a machine constructed with electro-magnets in 1872 by M. Gramme, which, with six others of the same kind, is in use in the well-known galvanoplastic establishment of Christofle and Co., of Paris. These machines weigh 750 kilogrammes, and the weight of copper used in their construction is about 175 kilogrammes. With a small engine of one-horse power, one of them will deposit 600 grammes of silver per hour. By some recent modifications in its construction this machine has been improved so as to increase the weight of silver deposited per hour to 2,100 grammes, or above $4\frac{1}{2}$ lbs. In Figs. 8 and 9 we have the forms of the Gramme Machine now in use for the production of the electric light. They are improvements on the machine which was tried on the Clock Tower of Westminster Palace. This machine had the defect of becoming heated while at work, and of giving sparks between the metallic bundles of copper wire and the conductors from the helices. In the machine represented in Fig. 8 these defects are said to have been completely remedied. The entire machine weighs 700 kilogrammes, and there are 180 kilogrammes of copper in the electro-magnets, and forty kilogrammes in the two rings. It produces a normal light of 500 Carcel burners; but, by augmenting the velocity, it is asserted that the amount of light may be doubled. It does not become heated, nor does it produce any spark where the brushes are applied.

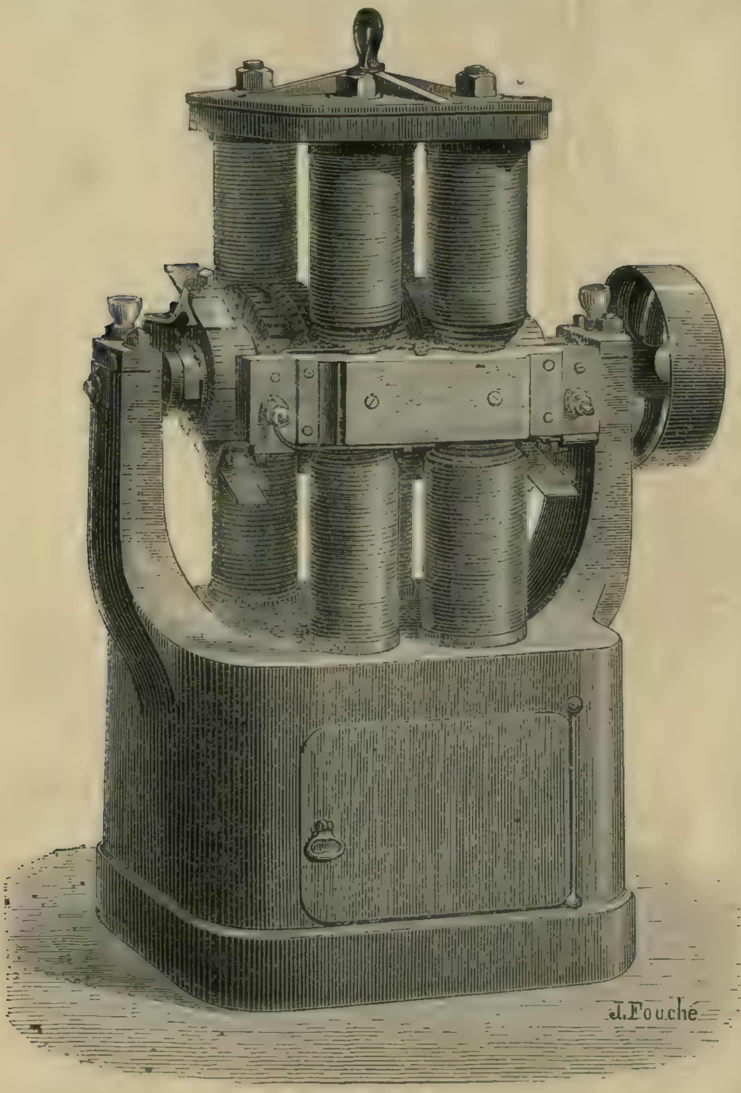

FIG. 7.—Gramme machine for metallic precipitations.

In Fig. 9 we have the latest improvements devised by M. Gramme for producing the electric light. In this machine there are only two bar electro-magnets and a single moveable ring placed between the electro-magnets. Its weight is 183 kilogrammes, and the entire weight of copper used in its construction, both for the ring and for the electro-magnets, amounts to forty-seven kilogrammes. Its normal power is about 200 Carcel burners, but this can be greatly augmented by increasing the velocity. It may be interesting to give the results of some experiments with this machine.

Number of turns.	Carcel burners.	Remarks.
650	77	No heating or sparks.
830	125	,, ,,
880	150	,, ,,
900	200	,, ,,
935	250	Slight heating, no sparks.
1025	200	Heating and sparks.

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* The substance of a Lecture, with additions, delivered at the Belfast Philosophical Society, March 17, by Dr. Andrews, F.R.S., L. & E. (Continued from p. 132.)

By uniting two or more machines together, electrical currents of high tension may be obtained. But a more useful arrangement is to divide into two each ring, so that the two halves may be joined either for quantity or tension, and varied effects thus obtained from the same machine. This is effected in the following manner. Suppose the machine to contain sixty bobbins or helices round the ring. If the entrance of the thirty alternate bobbins is placed on one side of the ring and of the thirty other bobbins on the other side, there will be in reality two ring-armatures in one, interlaced as it were into each other; and by collecting the currents by means of two systems of rubbers, one to the right and the other to the left of the ring, we may obtain from each one half of the electricity produced by the rotation of the ring. By applying this principle to machines for producing the electric light, the same machine may give two distinct lights instead of one. In its industrial applications, this is a point of capital importance. The use of the electric light is at present greatly interfered with by its excessive brightness, and the deep shadows which by contrast are produced at the same time. These defects will be to a large extent remedied by the use of two lights, so that the shadow from one may be illuminated by the other. It is proposed to use four electric lights, each of the strength of fifty Carcel burners, for lighting foundries and large workshops. In support of this proposal I may remark that I find Duboscq's lamp of the latest construction gives a singularly steady and mild light, with only twenty Bunsen's cells, and would of course work equally well with currents of the same intensity from a magneto-electric machine.

It would be impossible, within the limits of this lecture, to give an account of the proposed improvements in magneto-electric machines, which will be found in the records of the Patent Office during the last three years. I cannot, however, pass over without notice the machine of Siemens and Alteneck, in which electrical currents are obtained solely by the rotation of a longitudinal helix of insulated wire. This helix revolves in an annular space bounded externally by two semi-cylindrical magnetic poles, and internally by a stationary cylinder of iron, which latter may also be an independent magnet. The following account of this apparatus I give nearly in the words of the inventors. Between the poles of one or more magnets or electro-magnets, an iron core or cylinder is placed so as to leave a space between it and the faces of the magnetic poles, which have a cylindrical form, and are concentric with the iron cylinder. In this annular space a cylindrical shell of light metal is made to revolve, on which a coil of insulated wire is wound parallel to the axis of the shell, and crossing its ends from one side to the other. There may be several such coils each covering an arc of the periphery of the shell. The ends of these wires are

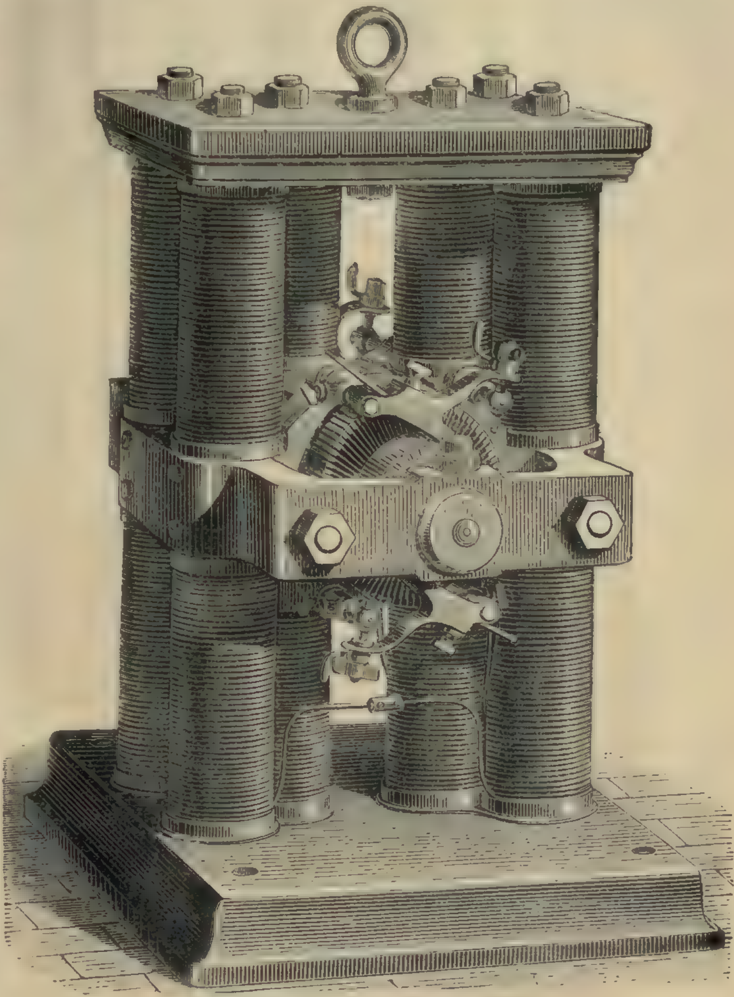

FIG. 8.—Gramme machine for electric light.

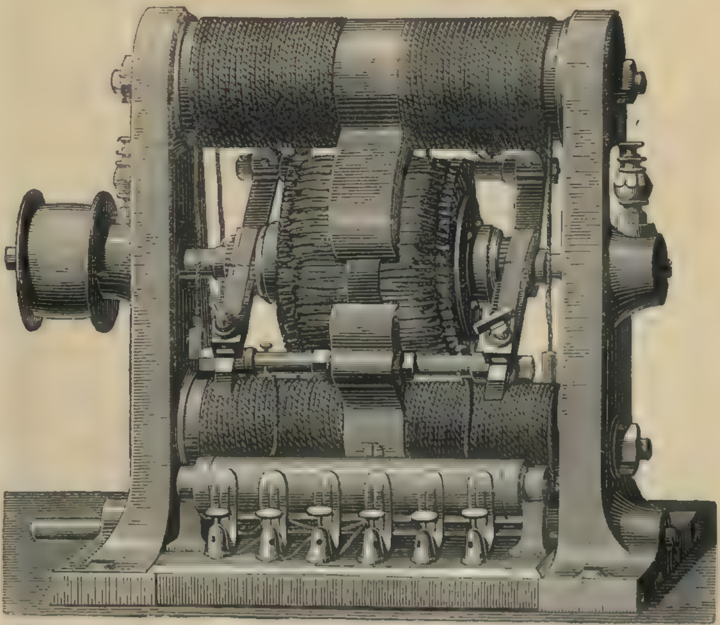

FIG. 9.—Gramme machine for electric light (latest form).

connected by metallic rollers or brushes with two stationary conductors, which are insulated, and constitute the poles of the machine. The currents obtained on rotating the shell may be made either continuous or intermittent, or they may be alternately reversed. The iron cylinder itself may be rendered magnetic by coiling upon it longitudinally an insulated wire after the manner of the rotating armature of Siemens.

To enumerate the possible applications of induction machines would be simply to describe all the applications which have already been made, or may hereafter be made, of current electricity to useful purposes. Among the former, the electric telegraph, the electric light, and electro-plating are perhaps the most important; among the latter, it will be sufficient to mention two proposals, one to facilitate the ascent of steep gradients by increasing, by means of magnetism, the adhesion of the wheels of locomotives to the iron rails; the other, to decompose, by electrolysis, common salt so as to obtain directly, and in a state of purity, the valuable chemical products hydrochloric acid and soda.

THE GOVERNMENT ECLIPSE EXPEDITION TO SIAM

THE following few details concerning the above Expedition will probably be of interest to the readers of Nature; having just returned from Siam, I am unable at present to give full particulars. The general results obtained by our party have already been published in this country by means of the telegraph. The fact that any results were obtained at all is far more than might have been expected considering the very brief time we had to adjust the instruments. We had only five days to land, unpack, fit up, and test the instruments, most of which were quite new and untried. This want of time was in the first place owing to unavoidable delays on the way out, and to the fact that there was no steamer ready to take us on to the Observatory Camp at once, thus necessitating a visit to Bangkok prior to the eclipse. Our partial success is in a large measure due to the valuable assistance of Capt. A. J. Loftus, an English gentleman in the service of his Majesty the King of Siam; Capt. Loftus was sent out by his Majesty to prepare the camp for us at Choulai Point.

As previous to our departure from London there appeared in one of the leading journals a letter, signed "Monitor," in which some very unpleasant statements were made with regard to the probable reception our party would receive in Siam—although Mr. D. K. Mason, the Siamese Consul in London, published at the time a total denial of the absurd insinuations—I feel it my duty, in the name of all who took part in the expedition, to state that during our prolonged stay in the kingdom of Siam we received nothing but the greatest hospitality and kindness. Everybody, from the King downwards, showed the greatest desire to make our visit as pleasant as possible, and to aid the expedition in every way; difficulties were surmounted at great expense and trouble, and everything we asked for was at hand or was obtained with the least possible delay. Our drinking-water was brought nearly 100 miles by water to the camp; many tons of ice were brought up from Singapore, and every kind of wine was ready at hand.

The King sent several of his officials, both European and Siamese, to assist us, and ordered such observations to be made at Bangkok as the chief of the expedition, Dr. Schuster, might consider of use to the expedition; the King himself observed and made a drawing of the corona. Our camp and observatory were situated some fifty miles from the city of Bangkok, on the west of the Gulf of Siam, in the central line of totality. On our arrival we found what had formerly been a waste of jungle converted into a magnificent camp, and all the houses fitted up ready for our reception.

The eclipse itself differed from former ones in respect to the greater brightness of the corona and the smallness and fewness of the red flames. As far as we could make out, the time as calculated by the *Nautical Almanack* was some ten seconds wrong.

In a "Reuter's" telegram, Dr. Schuster stated that the spectroscopic cameras had failed. As failures arise from many sources, this must be regarded as only a general statement. It merely implied that no results were obtained by these instruments, not that as instruments for observing eclipses they were found to be a failure. Several of the instruments were to have been tested during the outward voyage, but owing to the breaking-down of the *Surat*, and consequent transshipment of cases, no opportunity for such work was found, and, on arriving at the camp, the time was far too short, owing to other accidents, to enable anything like satisfactory focussing and adjustments.

There were two sets of instruments employed as telespectropes, one working in the large observatory, the other in the Siderostat Observatory, where we had the large new siderostat working with Mr. Lockyer's 9½-inch reflecting telescope and a spectroscopic camera. The first two instruments were in splendid order, working together beautifully, but the spectroscopic camera, not having been tested previously, could not be brought to give anything like a well-focussed photograph prior to the eclipse. The image of the corona, which appeared very distinct and bright on the slit-plate, although exposed during the whole of totality, gave no visible results on the photographic plate; even the sun itself, exposed for two seconds for the purpose of obtaining an index, gave likewise no result.

Before making any statements on the results obtained, I must wait the issue of the report of the Royal Society's Eclipse Committee.

Numerous drawings were sent in by the Siamese, which will be very valuable along with the general observations. After the eclipse, owing to three of our party being too ill to leave, we remained longer in the city of Bangkok than we had expected. During our stay Mr. and Mrs. Henry Alabaster, our hosts, on behalf of the King, entertained us in the most hospitable manner, taking care that those who were ill should have all possible attention, and be restored to health as fast as good doctors and kind nursing could accomplish it.

The following is a complete list of all who assisted us in the observatories during the eclipse, as well as of the members of the expedition sent out, with the part taken by each person:—

THE EXPEDITION.

Dr. **Arthur Schuster**.—Chief of the Expedition; in charge of large Observatory, attending to the Equatorial.

Frank Edward Lott.—Dr. Schuster's Assistant. In charge of the Siderostat Observatory.

F. **Beazley**, Jun.—Photographic Department. Developing negatives in dark room No. 1.

Oscar Eschke.—Photographic Department. Preparing plates in dark room No. 2.

Officers from H.M.S. Lapwing.

Hon. H. N. **Shore**, Lieut. R.N.—Taking drawings of Corona in large Observatory.

Andrew Leslie Murray, Nav. Lieut. R.N.—Keeping time in large Observatory by Chronometer from H.M.S. *Lapwing*.

W. J. **Firks**, Assist. Eng., R.N.—Attending to the clock of Mr. Penrose's instrument.

Europeans and Siamese from Bangkok.

Capt. A. J. **Loftus**, R.S.N.—Founder of the Observatory and Camp. In charge of Mr. Beazley's Camera, taking direct photographs of Corona with 2—4—8—16 seconds' exposure.

Mrs. M. Loftus.—Keeping time for Capt. Loftus.
Francis Chit.—Royal Photographer to the King. Preparing and developing in dark room No. 3 for Capt. Loftus.
W. Bray.—Attending to plates for Capt. Loftus.
F. G. Patterson.—Keeping time in large Observatory with Mr. Murray.
— Hendricke and W. H. Lang.—Attending to the Prismatic Camera in large Observatory.
C. Bethje.—Dr. Schuster's amanuensis during totality.
Capt. J. Thompson, R.S.N., and Edward H. Loftus.—Signalling time between the large Observatory and the Siderostat Observatory.
Capt. Chung, R.S.W.—In charge of thirty Siamese, guarding the Observatory ground.

Six Seamen from H.M.S. Lapwing.

Carpenter, Blacksmith, and Two Seamen in large Observatory, taking plates between dark rooms and instruments.
Two Seamen in Siderostat Observatory: one to bring plate from dark room and watch the Corona, and the other to open and shut the Camera slide.

It was not till the day of the eclipse that we got the instruments in anything like position, and even then they were but half tested. We then had a couple of rehearsals, and by mid-day everyone was fully prepared and thoroughly knew the part he would have to perform during totality. This was entirely due to the indefatigable and untiring manner in which Dr. Schuster examined into every detail, and to the readiness with which everyone, without exception, undertook the part allotted him, and did his utmost to understand all the requirements of the position.

After leaving Siam our party separated at Singapore, Dr. Schuster bound for Simla, Mr. Beazley for Japan and China, Mr. Eschke for Berlin, the writer alone returning to England with the results obtained by the Expedition.

FRANK EDW. LOTT

NOTES

The deaths of two eminent astronomers are announced: Prof. d'Arrest, of the University of Copenhagen, who died on June 14, in his fifty-third year; and Prof. Winlock, the distinguished Director of Cambridge Observatory, U.S.

We learn with the greatest pleasure that a thorough and systematic observation of the cirrus clouds is in the course of being established in other countries than Sweden. The great importance of these observations we recently urged on the attention of meteorologists in reviewing Dr. Hildebrandsson's "Essay on the Upper Currents of the Atmosphere," vol. xii. p. 123. Dr. Hildebrandsson has undertaken the discussion of these observations, and already the meteorological institutes and societies of Norway, Denmark, France, Austria, Portugal, and Scotland have promised their assistance and agreed to send to Sweden observations from several stations in their respective countries.

The following Commission has been appointed to inquire into "the practice of subjecting live animals to experiment for scientific purposes, and to consider and report what measures, if any, it may be desirable to take in respect of any such practice:"—Viscount Cardwell, Baron Winmarleigh, W. E. Forster, Sir J. B. Karslake, Prof. Huxley, Prof. Erichsen, and R. H. Hutton.

Dr. Gerald F. Yeo has been elected to the professorship of Physiology in King's College, London.

In vol. xi. p. 475, we announced the discovery of a boiling lake in the island of Dominica. The *Trinidad Chronicle* of May 21 contains an account of a visit to the spring by Mr. H. Prestoe, superintendent of the Trinidad Botanic Gardens. The lake lies in the mountains behind Roseau, and in the valleys around many *souffrières*, or solfataras, are to be met with. The Boiling Lake is a gigantic solfatara, with an excess of water-volume over the ejective power exerted by its gases and heat. It is affected by a very considerable volume of water derived from two converging ravines which meet just on its north-west corner, and owing to the existence of a small hill immediately opposite (which has had the effect of diverting the course of the ravine-water into its present channel), the action of the solfatara has caused the formation of a crater-like cavity, which is now the Boiling Lake with its precipitous and ever-wasting banks on its north and south sides, of some sixty feet depth. The temperature of the lake ranges from 180° to 190° F. The point of ebullition seems to vary its position somewhat; the water rising two, three, and sometimes four feet above the general surface, the cone dividing occasionally into three, as though ejected from so many orifices. During ebullition a violent agitation is communicated over the whole surface of the lake. The sulphurous vapour arises in pretty equal density over the whole lake, there being no sudden ejection of gas observed from the point of ebullition; there are no detonations; the colour of the water is a deep dull grey, and it is highly charged with sulphur and decomposed rock. As the outlet of the water is constantly deepening, the surface of the lake must gradually become lower, and it will, Mr. Prestoe thinks, ultimately be destroyed, and its character be changed to that of a geyser. It will then gradually fill up by the reduction of the adjacent hill-sides, and innumerable solfataras will be formed in the place of the present gigantic one. Mr. Prestoe found no bottom with a line of 195 feet, ten feet from the water's edge. One great result of the action of solfataras is the decomposition of the volcanic rock and the development therefrom of various kinds of gypsum. Some blocks met with have a very strong resemblance to the Tuscany or Volterra marble. Mr. Prestoe thinks that these large solfataras have had much to do in bringing about the present conformation of the district.

Dominica, which was formerly one of the chief coffee-producing countries, has of late years almost entirely ceased to grow the plant. The capabilities of the island, however, are apparently so great, not only for the cultivation of coffee, but also for many other food products, that the attention of the authorities has been directed to the matter, and the result is that Mr. Prestoe, of the Botanic Gardens, Trinidad, has been commissioned to examine and report on the prospects of the island generally, and the best means of developing its resources. We anxiously await the details of Mr. Prestoe's report upon an island so fertile and beautiful as Dominica, but which has, no doubt, through want of European capital and energy, been allowed to drift almost into an unprofitable waste.

The *Times* of last Thursday contains a letter, dated Yokohama, April 11, from its correspondent on board the *Challenger*, giving an account of the cruise from Mindanao by New Guinea and the Admiralty Islands to Japan. An extremely interesting account is given of the natives of New Guinea at Humboldt Bay and of the Admiralty Islanders. The following are the principal results of the soundings made:—The greatest depth in the section, 2,250 miles long, from the Admiralty Islands to Japan, was found on the 23rd of March in 4,575 fathoms, between the Carolines and Ladrones. This is the deepest trustworthy sounding on record, with the exception of two taken by the *Tuscarora* off the east coast of Japan, in 4,643 and 4,655 fathoms respectively, but no sample of the bottom was procured on either of these occasions. A second sounding gave 4,475 fathoms. The tube of the sounding machine contained an excellent sample of the bottom, which was of a very peculiar character, consisting almost entirely of the siliceous shells of *Radiolaria*. Three out of four Miller-Casella thermometers sent down to these depths were crushed to pieces by the enormous pressure they had to bear: the fourth withstood the pressure, and registered, when corrected for the pressure, at 1,500 fathoms, the usual temperature for that depth, 34°·5 F.; so that at that place there is a layer of water at that uniform temperature occupying the bottom of the ocean trough of the enormous thickness of 3,075 fathoms (18,450 feet). The observations made in this section, taken in connection with others made elsewhere, would seem to point to the following law:—That "Globigerina ooze"—a rapidly forming deposit, containing the whole of the abundant carbonate of lime of the shells of the Foraminifera living on the surface and beneath it, and consequently consisting of almost pure carbonate of lime—generally occupies depths under 2,000 fathoms in the ocean; that beyond this depth, the proportion of the calcareous matter is gradually diminished, and the deposit, which now contains a considerable amount of clay, goes under the name of grey ooze; that at 2,600 fathoms the calcareous matter has almost entirely disappeared, and we have the purest form of "red clay," a silicate of alumina and iron with siliceous tests of animals; that from this point the "clay" decreases in proportion, and the siliceous shells increase, until at extreme depths the "clay" is represented by little more than a red cement, binding the shells together. As to the transition from the "Globigerina ooze" to the "red clay," the *Times* correspondent says, it is due to the removal of the lime of the Globigerina shells by water and carbonic acid, or in some other way; the apparent disappearance of the "red clay" is a fallacy produced by the increased proportion of the siliceous shells. It has now been ascertained by the use of the tow-net at great depths that Radiolarians and Diatoms inhabit the water all the way down, and are probably more abundant at greater depths; and it follows from this that four times more, at least, must die and shed their tests in 4,000 fathoms than in 1,000 fathoms. The most marked temperature phenomenon observed in the two sections was the presence of a surface layer of water of an average depth of 80 fathoms, and a temperature above 77° F., extending northwards from the coast of New Guinea about 20°, and westward as far as the meridian of the Pellew Islands. The greater part of this huge mass of warm water is moving with more or less rapidity to the westward.

M. JANSSEN was present at Monday's sitting of the Paris Academy.

THE preparations for the Geographical Congress in Paris are being actively completed. The large map of France executed by the staff officers will be exhibited, all the sheets having been joined, thus forming one continuous sheet of paper of immense size. The map will be exhibited at the Tuileries in the Salle des États. It will be photographed by the microscopical and panoramic process. There is a law prohibiting valuable documents in the National Library, Paris, from being taken out of the building. But a large hall will be set apart for their exhibition, and all the members of the Geographical Congress will get free admission to view them as often as they may desire.

M. LEVERRIER, at Monday's sitting of the Paris Academy, intimated that the great reflecting telescope, and other large apparatus, will be ready for inspection by the members of the Geographical Congress on their visit on the 5th of August.

MR. A. J. ANDERSON, from Manchester Grammar School, and Mr. T. W. Stubbs, from Clifton College, have been elected to Demyships in Natural Science in Magdalen College, Oxford. Mr. H. A. Wilson, of Magdalen College School, was at the same time elected to the Exhibition in Natural Science. The stipend of the Demyships is 95*l*. per annum, and of the Exhibition 75*l*. They are tenable for five years.

S. NALL has been elected to a Foundation Scholarship for proficiency in Natural Science at St. John's College, Cambridge. Stewart, Lowe, and Houghton to Exhibitions.

J. T. MÖLLER, of Wedel (Holstein), having been repeatedly requested to publish his process of preparing Diatomaceæ, has resolved to adopt the following plan:—If a sufficient number of subscribers is obtained, he will publish a work with illustrations, under the title of "The Preparation of the Diatomaceæ," which will contain—1. The collecting; 2. The cleaning and purifying (*a*) of the living subjects; (*b*) of dead subjects in the mud; (*c*) of fossils. 3. The separation of the different species. 4. The preparation and mounting (*a*) in the ordinary manner—in quantity; (*b*) as selected and arranged; (*c*) as "Typen- and Probe-platte," &c.

WE believe that the *Pandora*, which has just sailed to attempt the north-west passage, has been fitted out at the joint expense of Lady Franklin, Mr. James Gordon Bennett, Lieut. Lillingston, and Capt. Allen Young—the last-mentioned, however, bearing the major portion of the cost, as well as the whole risk of the voyage. We are glad to hear that the health of Lady Franklin, who has been seriously ill, has considerably improved. On Monday evening the *Pandora* finally left Plymouth for Disco. On the same day, the *Times* says, there was to sail from Sunderland Dock a small sloop named the *Whim*, bound to the Arctic seas and zone; it is under the command of Capt. Wiggins, of the merchant service, and is manned by five able seamen. The little vessel is only twenty-seven tons register. Capt. Wiggins is bound for the Russian coast.

ON Monday evening an extraordinary meeting of the Royal Geographical Society was held, at which the Seyyid of Zanzibar who was present, was received with great enthusiasm, and expressed his anxiety to do all in his power to forward the objects of the Society. Mr. John Forrest gave an account of his journey across the western half of Australia, from Champion Bay on the west coast to the Overland Telegraph line. We have already given some details of the journey in vol. xi. p. 93. Mr. Forrest concluded by stating that all the geographical problems have now been finally solved, and the only remaining portion of interest is the small part in the north-west corner from Roebuck Bay to the Victoria River.

AT the above meeting Dr. W. B. Carpenter read a paper on recent observations on ocean temperature made in the *Challenger* and *Tuscarora*, with their bearing on the doctrine of a general oceanic circulation, sustained by difference of temperature.

UNDER the heading of "Early Indications of Spectroscopy in America," the *American Chemist* for May reprints two papers by Dr. David Alter, from the *American Journal of Science* of 1854 and 1855, in which he describes some experiments made by him on the spectra of metals and gases, at least three years before the publication of the researches of Bunsen and Kirchhoff.

THE Sub-Wealden Exploration has made considerable progress during the past week. A further depth of 108 feet has been reached in five days, making a total of 1,246 feet.

THE most interesting objects which attract attention at the Southport Aquarium just now are the eggs of the Rough Hound (*Squalus catulus*), which were deposited in the tanks about the beginning of December of last year. All the eggs seem to be in a healthy condition, and the young fish are now so far advanced that their movements within their horny cases can be distinctly traced, and possibly only a short interval will elapse before they are completely free. Mr. Long anticipates a similar result from the eggs of the Skate (*Raia batis*) deposited in February last. The fine Sturgeon about eight feet long, and about thirty specimens of the Sea-horse (*Hippocampus brevirostris*) are also objects of much interest.

WITH reference to our note (vol. xii. p. 135) on the attempt to acclimatise humming-birds in Paris, a correspondent informs us that Mr. Gould some years ago succeeded in bringing a living pair within the confines of the British Islands, and a single individual to London, where it lived two days. The birds were quite lively during the voyage across the Atlantic, but began to droop when off the coast of Ireland; and, as we have said, Mr. Gould succeeded in bringing only one to London alive. Particulars will be found in Mr. Gould's "Monograph of the Trochilidæ."

FURTHER details are to hand of the earthquake which on May 18 caused so much destruction in the valley of Cucuta, in the Republic of New Granada. The destruction to life and property has been almost unprecedented. The German drug store, it is stated, was set on fire by a ball of fire that was thrown out of the volcano, which, at the time the news left, was constantly belching out lava. The volcano has opened itself in front of Santiago, in a ridge called El Alto de la Giracho. In reference to this, see the letter we publish to-day from Mr. W. G. Palgrave.

THE final arrangements have been made for holding the forty-third annual meeting of the British Medical Association, which meets in Edinburgh this year on August 3, under the presidency of Prof. Sir Robert Christison, Bart.

AN exhibition is to be held in Belgium next year of all such apparatus, sanitary arrangements, or scientific appliances as are calculated to preserve health or to save life.

WITH the *Gardener's Chronicle* of last Saturday is published a beautifully illustrated supplement, giving an account of Chatsworth, the seat of the Duke of Devonshire.

THE Brussels Académie Royale has just published a new edition of its "Notices Biographiques et Bibliographique." This volume contains a brief sketch of the history of the Academy, a list of Presidents, honorary, corresponding, and ordinary members and associates in the various classes, followed by brief biographical notices of all the members who have contributed papers, with full lists of their contributions. The volume is a very valuable as well as a very interesting one.

MESSRS. TRÜBNER AND CO. have published a pamphlet by Dr. A. Stœcker (translated by Dr. Harrer) giving much useful information concerning the baths and mineral springs of Wildungen, about one hour's distance from Cassel. The springs, of which there are five in use, are more or less alkaline-chalybeate, and seems to possess important curative qualities. In connection with this subject the following recently published statistics of the numbers of patients that visited the German and Hungarian watering-places during 1874 will be interesting:—Baden-Baden, 41,464; Buziasch, 813; Carlsbad, 20,235; Elster, 4,373; Franzensbad, 7,655; Gleichenberg, 3,373; Gastein, 1,253; Gmunden, 1,202; Giesshübl, 12,625; Gräfenberg, 847; Hall, 2,000; Ischl, 9,386; Ilmenau, 1,468; Krankenheil, 1,010; Königswart, 313; Neuenahr, 3,405; Oeynhausen, 3,254; Kryniza, 2,080; Luhatschowitz, 942; Marienbad, 9,861; Nanheim, 4,152; Pystian, 1,709; Reichenhall, 4,215; Reinerz, 2,352; Rohitsch, 2,603; Szczawinca, 2,033; Teplitz-Trentschin 1,655; Tüffer, 2,061; Vöslau, 3,865; Wartenberg, 805; Warmbrunn, 1,960; and Wiesbaden, 65,800.

THE additions to the Zoological Society's Gardens during the past week include a Black-backed Jackal (*Canis mesomeles*) from S. Africa, presented by Messrs. Donald Currie and Co.; an Indian Coucal (*Centropus rufipennis*) from India, presented by Mrs. Hunter Blair; a Small Hill Mynah (*Gracula religiosa*) from S. India, presented by Sir Charles Smith, Bart.; a Golden Eagle (*Aquila chrysäetos*) from India, presented by Mrs. Logan Horne; two Chinese Quails (*Coturnix chinensis*) from China, presented by Mr. A. Jamrach; two Virginian Eagle Owls (*Bubo virginianus*) from N. America, deposited; two White-winged Choughs (*Corcorax leucopterus*) from Australia, a Salle's Amazon (*Chrysotis sallœi*) from St. Domingo, purchased; five Australian Wild Ducks (*Anas superciliosa*) bred in the Gardens.

RECENT PROGRESS IN OUR KNOWLEDGE OF THE CILIATE INFUSORIA *

III.

IT follows from this view that the cavity of the Cœlenterata would represent an intestinal cavity only, while a true body cavity would be here entirely absent. This way of regarding the cavity of the Cœlenterata is at variance with the conclusions of most other anatomists who regard the cœlenterate cavity as representing a true body cavity, or a body and intestinal cavity combined. I had myself long entertained the generally accepted opinion that the cavity of the Cœlenterata represents a body cavity. I must, however, now give my adhesion to the doctrine here advocated by Haeckel, and regard the proper body cavity of the higher animals as having no representative in the Cœlenterata. I believe that this is supported both by the facts of development and by the structure of the mature animal. Indeed, the body cavity first shows itself, as Haeckel has pointed out, in the higher worms, and is thence carried into the higher groups of the animal kingdom.

If such be the real nature of a true intestinal cavity and of a true body cavity, it is plain that neither the one nor the other can exist in the Infusoria, for there is here nothing which can be compared with either the endoderm or the ectoderm.

The whole, then, of the alleged chyme of the Infusoria is nothing more than the internal soft protoplasm of the body. It is quite the same as in Amœba and many other unicellular animals.

The peculiar currents which have been long noticed in the endoplasm of many Infusoria must be placed in the same category with the rotation of the protoplasm observed in many organic cells. Von Siebold, indeed, had already compared the endoplasm currents of the Infusoria to the well-known rotation of the protoplasm in the cells of Chara.

The presence of a mouth and anal orifice in the ciliate Infusoria has been urged as an argument against the unicellular nature of these organisms. The so-called mouth and anus, however, admit of a comparison not in a *morphological* but only in a *physiological* sense with the mouth and anus of higher animals. They are simple lacunæ in the firm exoplasm, and have, according to Haeckel, no higher morphological value than the "pore canals" in the wall of many animal and plant-cells, or the micropyle in that of many egg-cells. Kölliker had already compared them to the excretory canal of unicellular glands. Since, therefore, they do not admit of being homologically identified with the orifices of the same name in the higher animals, Haeckel proposes for them the terms "*Cytostoma*" and "*Cytopyge*."

So also the presence of a contractile vesicle and of other vacuoles affords no solid argument against the unicellularity of the Infusoria. The physiological significance of the contractile vesicles has been variously interpreted. In certain cases a communication with the exterior appears to have been demonstrated, and Haeckel regards them as combining two different functions of nutrition, namely, respiration and excretion. They are in all cases destitute of proper walls, and they have been long recognised as morphologically nothing more than lacunæ filled with fluid. Regular contractile vesicles differing in no respect from those of the ciliate Infusoria are often found in the Flagellata and in the swarmspores of many Algæ.

Besides the constant and regular contracting vacuoles, there occur also others less constant and less regularly contracting. These are found in the softer endoplasm, while the constant and regularly contracting vacuoles occur for the most part in the firmer exoplasm. One is just as much a wall-less vacuole as the other, and the difference between them is to be traced to the difference of consistence in the surrounding protoplasm. Haeckel regards the less constant ones as the original form from which the others have been phylogenetically derived, that is, by a process of inheritance and modification through descent.

The last and most important of the parts which enter into the formation of the Infusorium body, namely, the nucleus, is next discussed. Viewed from a morphological point, it has been already demonstrated that the nucleus is in all Ciliata originally a single simple structure, resembling in this respect a true cell-nucleus. As the Infusorium body approaches maturity we find that with its advancing differentiation peculiar changes occur in the nucleus just as in the rest of the protoplasm, but these changes are entirely paralleled by differentiation phenomena which are known in other undoubted cell-nuclei, as, for example, in the germinal vesicle of many animals, in the nuclei of many unicellular plants, the nuclei of many parenchyma cells of the higher plants, and the nuclei of many nerve-cells. The mature Infusorium nucleus is often vesicle-like, and consists of a delicate investing membrane and fine granular contents, precisely as in the differentiated nucleus of many other cells. In many Ciliata, if not in all, there is within the young nucleus a dark, more refringent corpuscle, which has quite the same relations as the nucleolus of a true cell-nucleus.

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* Anniversary Address to the Linnean Society, by the President, Dr. G. J. Allman, F.R.S., May 24. Continued from p. 157.

Regarded from a physiological, no less than from a morphological point of view, the Infusorium nucleus and true cell nucleus admit of a close comparison with one another. It may be considered as established by the concurrent observations of all investigators, that the nucleus of the Infusoria performs the function of a reproductive organ, though the opinions entertained as to the mode in which it thus acts are extremely divergent.

It is now admitted that in the reproduction of unicellular organisms both in the animal and vegetable kingdom, the nucleus takes an important part, and by its division as a primary act ushers in the division of the rest of the protoplasm. Even in the cells which form constituents of tissues, the part played by the nucleus is altogether similar, its division always preceding the division of the cell itself.

In quite a similar way does the nucleus behave in the ciliate Infusoria. The non-sexual reproduction of the Infusoria by division is perhaps universal. In such cases the division always begins by the spontaneous halving of the nucleus, and this is followed by a similar division of the surrounding protoplasm, exactly as in the ordinary simple cell.

Another phenomenon in which the nucleus plays an important part is named by Haeckel "spore formation." Under this designation he comprehends all those cases in which—the idea of a previous fecundation being rejected—the nucleus breaks into numerous pieces, and each of these, apparently by becoming encysted in a portion of the protoplasm of the mother body, shapes itself into an independent cell—a so-called germ-globule, (*Keimkugel*). Now this is a true spore—just as much so as the spores which arise quite in the same way in unicellular plants. The whole process is to be regarded as a case of the so-called endogenous multiplication of cells.

Most authors, however, take a different view of the nucleus. Following Balbiani, they regard it as an ovary; and to the fragments into which it breaks up they assign the significance of eggs; while the so-called nucleolus, which lies outside the nucleus, is, as we have seen, believed to be a testis in which spermatozoa are developed for the fecundation of the eggs.

We must bear in mind, however, that this "nucleolus" has been hitherto found in but a disproportionately small number of species, while the spermatozoal nature of the apparent filaments which have been noticed in it has by no means been proved; and we have already seen that some observed facts such as those adduced by Bütschli are opposed to the view which would assign to them the nature of true spermatozoa.

As Haeckel remarks, however, even though the so-called nucleolus be really a testis fecundating the eggs or fragments derived from the breaking up of the nucleus, this would afford no valid argument against the unicellularity of the Infusoria, for precisely the same sexual differentiation and reproduction are found in unicellular plants.

It may now, then, be regarded as proved that the process by which the body of the ciliate Infusorium attains a certain degree of differentiation is repeated not only in other unicellular organisms, but in many parenchyma cells both of plants and animals. The difference, as Haeckel with much force points out, between the differentiation process of these parenchyma cells and that of the Infusorium body consists in the fact that in the parenchyma cells the differentiation is a one-sided one, conditioned by the division of labour in the organism of which they form the constituents, while in the Infusorium it is a many-sided one related to all the different directions in which cell-life manifests itself, and resting on a physiological division of labour among the "plastidules" or protoplasm molecules. In other words, the differentiation processes which in multicellular organisms are found distributed among different cells, are united in the single cell of the ciliate Infusorium, thus leading to the formation of an animal very perfect in a physiological point of view, but which morphologically does not pass the limit of a simple cell.

In some rarer cases the Infusorium body is found to enclose two or more nuclei, and Haeckel admits that such Infusoria must strictly be regarded as multicellular, since the nucleus in itself alone determines the individuality of the cell; but these exceptional cases have no significance for the main conception of the infusorial organism. The multiplication of the nucleus exerts almost no influence on the rest of the organisation, and such "multicellular ciliata" are to be compared with the colony-building forms of the Acinetæ, Gregarinæ, Flagellatæ, and other undoubtedly unicellular organisms.

In conclusion, Haeckel considers the systematic position of the Infusoria. That they are genuine *Protozoa*, having no direct relation to either the Cœlenterata or the Worms, must be now admitted. To this result we are led in the most convincing way by all that we know of their development. In all the animal types which stand above the Protozoa, the multicellular organism is developed out of the simple egg cell by the characteristic process of segmentation, and the cell masses so arising differentiate themselves into two layers—the endoderm and the ectoderm, or the two primary germ lamellæ.[*] Resting on the fundamental homology of these two layers in all the six higher types of the animal kingdom, Haeckel had already[†] directed attention to the fact that all these types pass in their development through one and the same remarkable form, to which he gives the name of Gastrula, and which he regards as the most important and significant embryonal form of the whole animal kingdom. This gastrula consists of a multicellular, usually oviform uniaxial, body enclosing a simple cavity—the primordial stomach or intestine cavity, which opens outward on one pole of the axis by a simple orifice—the primordial mouth, and whose walls are composed of two layers, the endoderm or inner germ lamella, and the ectoderm or outer germ lamella.

This larval form has now been shown by the researches of Haeckel, Kowalevsky, Ray Lankester, and others, to occur in members of all the six higher primary groups of the animal kingdom; and Haeckel, in conformity with what he has called the biogenetic fundamental law[‡]—the recapitulation of ancestral forms in the course of the development of the individual—had already in a former work[§] concluded in favour of a common descent of all the six higher types from a single unknown ancestral form which must have been constructed essentially like the Gastrula, and to which he gives the name of *Gastræa*.

From this common descent the Protozoa alone are excluded, these not having yet attained to the formation of germ lamellæ or of a true intestinal cavity.

He regards this difference between the development of the Protozoa and that of all the other animal types as so important, that he founds thereon a fundamental division of the whole animal kingdom into two great primary sections—the *Protozoa* and the *Metazoa*. The former never undergo segmentation, never develop germ lamellæ, and never possess a true intestinal cavity; the latter, which include all the other types of the animal kingdom, present a true segmentation of the egg cell, have all two primary germ lamellæ—endoderm and ectoderm—a true intestine formed from the endoderm, and a true epidermis from the ectoderm; they all pass through the form of the gastrula, or an embryonic form capable of being immediately deduced from it, and (hypothetically) are all descended from a Gastræa.

The only Metazoa which in their existing condition have no intestine are the low worm-groups—Cœstoda and Acanthocephala—but these form only an *apparent* exception, for the loss of their intestinal canal is a secondary occurrence caused by parasitism, and Haeckel regards them as having descended from worms in which the intestine was present.

Several years ago Haeckel united into a separate kingdom, under the name of Protista, certain low organisms, some of which had been previously placed among the Protozoa, while others had been assigned to the vegetable kingdom. To this neutral group he refers the Monera, the Flagellatæ, the Catallactæ, the Labyrinthuleæ, the Micromycetæ, and the Acytariæ and Radiolariæ. After the elimination of these there remain as genuine Protozoa the Amœbinæ, the Gregarinæ, the Acinætæ, and, above all, the the true Infusoria or Ciliata.

The union of the Protista into a distinct kingdom equivalent in systematic value with the animal or vegetable kingdom, can, however, scarcely be maintained. We already know enough of some of them to justify our assigning these to one or other of the two generally accepted organic kingdoms; and there can be little doubt that, did we know the whole history of the others, as well as the essential difference between the animal and vegetable kingdom, these, too, would be referred without hesitation either to the one or to the other, some passing to the former and others to the latter. The group of the Protista is thus at best but a provisional one, based partly on our ignorance of the structure and life-history of the beings which compose it, and partly on our inability to assign to the animal its essential difference from the plant. Haeckel, however, has done well in specially directing attention to it, and in his admirable researches on many of the organisms which he has thus grouped together he has largely contributed to our knowledge of living forms.

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[*] The comparison of the endoderm and ectoderm of the Cœlenterata to the two primary germ lamellæ of the Vertebrata was first made by Huxley.

[†] "Die Kalkschwämme," 1872.

[‡] "Generelle Morphologie."

[§] "Die Kalkschwämme.

I have thus dwelt at considerable length upon this important paper of Haeckel's, because I think that it not only brings out in a clear light the essential features of infusorial structure and physiology as demonstrated by recent research, but that it goes far to set at rest the controversy regarding the unicellularity and multicellularity of the Infusoria.

Balbiani has quite recently published a very interesting account of the remarkable Infusorium long ago described by O. F. Müller under the name of *Vorticella nassuta*, and more recently taken by Stein as the type of his genus Didinium.

The animal, which is somewhat barrel-shaped, with an anterior and a posterior wreath of cilia, has one end continued into a proboscis-like projection which carries the oral orifice on its summit, while an anal orifice is situated on the point diametrically opposite to this. There is a very distinct cuticle, though the rest of the cortical layer is very thin, and can scarcely be optically distinguished from the internal parenchyma, which exhibits manifest currents of rotation. These flow in a continuous sheet along the walls from the anal towards the oral side, and on arriving at the mouth turn in towards the axis and then flow backwards along this until they complete the circuit by once more reaching the anal side of the body. No trichocysts are developed in the walls of the body. The contractile vesicle is large, and is situated near the anal end; it presents very distinct pulsations, and Balbiani is disposed to believe in a communication between it and the exterior.

During the act of digestion a tubular cavity can be seen running through the axis of the body, and connecting the oral and anal orifices. This is regarded by Balbiani as a permanent digestive canal. The post-oral or pharyngeal portion of this tube possesses a very remarkable feature, namely, a longitudinal striation caused by rigid rod-like filaments which are developed in its walls, and which can be easily detached and isolated by pressure or by the action of acetic acid. They then resemble some common forms of the raphides developed in the cells of plants. The function of these rods becomes apparent when the animal is observed in the act of capturing its prey. The Didinium is eminently voracious and carnivorous, and when in pursuit of other living Infusoria, such as Paramecium, the prey may be seen to become suddenly paralysed on its approach. A careful examination will then show that the Didinium has projected against it some of its pharyngeal rods, and to the action of these bodies the arrest of motion is attributed. A curious cylindrical tongue-like organ is now projected from the mouth towards the arrested prey, to which it becomes attached by its extremity. By the retraction of this tongue the prey is now gradually withdrawn towards the mouth, engulphed in the distended pharynx, and pushed deeper and deeper into the axial canal, where it is digested, and the effete matter ultimately expelled through the anus.

From all this Balbiani concludes against the unicellular doctrine. He sees in the axial cavity a permanent alimentary canal, and in the surrounding parenchyma a true perigastric space filled with a liquid which corresponds with the perigastric liquid of the polyzoa and of many other lower animals. He is not, however, disposed to make too broad a generalisation, and to insist on the presence of an alimentary canal distinct from a body cavity in all the other Infusoria. Here, however, he falls in with the views of Claparede and Lachmann and of Greeff, and maintains that as a rule the digestive and body cavity in the Infusoria are confounded into a single gastrovascular system.

Independently, however, of the untenableness of the conception of a united digestive and body cavity, it does not appear to me that Balbiani makes out any case against the unicellularity of the Infusoria. He admits that except in the pharyngeal and anal portion there is no evidence of a differentiated wall in his so-called digestive canal, and even though it be conceded that the middle portion of this canal constitutes a permanent cavity in the parenchyma, it would not differ essentially from other lacunæ permanently present in the protoplasm of many undoubtedly unicellular organisms. It has been already remarked that a communication between these lacunæ and the external medium is paralleled in many simple cells, and these external communications in Didinium present no feature essentially different.

The pharynx appears to be bounded by an inflection of the cortical layer, and I believe we may regard the rod-like corpuscles here present as a peculiar modification of the trichocysts which in many other Infusoria are developed in the cortical layer of the body. The projectile tongue-like organ is one of the most remarkable features of Didinium; we must know more, however, than Balbiani has told us of it, before we can decide on its real import. It is not improbably a pseudopodial extension of the protoplasm.

Balbiani has followed the Didinium through the process of transverse fission. This is preceded by the formation of two new wreaths of cilia, between which the constriction and division takes place, each half previously to actual separation developing within it such parts as it had lost in the act of division. The only part which in this act becomes divided between the two resulting animals is the nucleus. The so-called nucleolus was not seen by Balbiani, and though he observed two individuals in conjugation by their opposed oral surfaces, he never witnessed anything like the formation of eggs or embryos.

I believe I have now laid before you the principal additions which during the last few years have been made to our knowledge of the Infusoria. But though it will be seen that the labourers in the special field of microscopical research, to which I have confined this address, have been neither few nor deficient in activity, it must not be imagined that the subject has been exhausted, or that many questions, more especially such as relate to development, do not yet await the results of future investigations for their solution.

PRIZES OF THE FRENCH ACADEMY

As our readers are aware, the Paris Academy of Sciences holds at the end of December each year a solemn meeting for hearing *éloges* of the departed members, and delivering prizes to the most deserving essayists. But owing to the calamity of the war the prizes for 1873 were distributed in the end of 1874, and the prizes for 1874 remained undistributed. An extraordinary solemnity was celebrated on June 21, for the distribution of the 1874 prizes, and henceforth we hope nothing will prevent the Academy fulfilling its yearly duties with punctuality. M. Bertrand, the new perpetual secretary, read an essay on the life and works of M. Élie de Beaumont, his predecessor in the office. Since Abbé Duhamel, the first of these perpetual secretaries, died, this has been the constant practice. So Abbé Duhamel was praised by Fontenelle, Fontenelle by Fouchy, Fouchy by Condorcet, &c. &c. But M. Élie de Beaumont did not produce any *éloge* on Arago; it will be the next duty M. Bertrand will have to perform, and a very attractive one it is. The following are the results of last year's competition as announced at the meeting:—

1. Grand Prize in the Mathematical Sciences for a Mathematical Theory of the Flight of Birds was not awarded, though 2,000 francs were given to M. Penaud, the author of one of the memoirs, and an "encouragement" of 1,000 francs to the two authors of another memoir, MM. Hureau de Villeneuve and Crocé-Spinelli.

2. This was also the case with the Grand Prize in the Physical Sciences, the subject being Fecundation in Mushrooms. The value of the prize was, however, divided between the authors of two memoirs, viz., MM. Maxime Cornu and Ernest Rose, and M. Sicard.

3. The Poncelet Prize in Mechanics was awarded to M. Bresse, Engineer-in-chief des Ponts et Chaussées, for his work entitled "Cours de Mécanique Appliquée," and particularly for the great progress shown in the part devoted to the resistance of materials.

4. The Montyon Prize in Mechanics to M. Peaucellier, Lieutenant-Colonel of Engineers, for his researches on the transformation of alternate rectilineal motion into alternate circular motion.

5. The Plumey Prize to M. Joseph Farcot for his *servo-moteur*, or *moteur-asservi*, an apparatus which renders the action of the rudder more certain and more easy.

6. The Lalande Prize in Astronomy is a sextuple one, and was divided among MM. Mouchez, Bouquet de la Grye,

Fleuriais, André, Héraud, and Tisserand, as a reward for their observations of the Transit of Venus.

7. The Montyon Prize in Statistics was awarded to M. de Kertanguy, and honourable mention was made of MM. de St. Genis and Loua.

8. The Jecker Prize was divided into two, 3,000 francs being awarded to Prof. Reboul of Besançon for his work on the Ethers of Glycide and on the Hydrocarburets; and 2,000 francs to M. Bouchardat for his researches on the Ethers of Mannite and of Dulcite.

9. The Desmazières Prize was awarded to M. J. de Seynes for his study of many cryptogamic plants belonging to the genus *Fistulina*, and especially of *F. hepatica*.

10. The Fons Mélicoq Prize was divided by way of encouragement between M. Calley, author of a catalogue of vascular plants of the Department of Ardennes, and MM. Eloi de Vicq and Blondin de Brutelette, authors of a Catalogue Raisonné of vascular plants of the Somme.

11. The Thore Prize in Anatomy and Zoology, to M. Auguste Forel for his work "Les Fourmis de la Suisse."

12. The Bréant Prize of 100,000 francs always offered for the treatment of cholera was not awarded. A reward of 3,500 francs was accorded to M. Ch. Pellarin for his studies on the character and modes of transmission of cholera. For similar studies a reward of 1,500 francs was given to M. Armieux.

13. The Montyon Prize in Medicine and Surgery was divided as follows:—2,400 francs each to MM. Dieulafoy, Melassez, and Méhu: honourable mention and 1,000 francs to MM. Béranger-Féraud, Létiévant, and Péter.

14. Two Montyon Prizes of equal value, in Experimental Physiology, were awarded, one to MM. Arloing and Tripier for their experimental research on the conditions of persistence and sensibility in the peripherical end of divided nerves; and the other to M. Sabatier for his studies on the heart and the central circulation in the Vertebrata.

15. The proceeds of the Tremont Prize for 1873-4-5 were awarded to Prof. Achille Cazin.

16. The Gegner Prize was given to M. Gaugain to aid him in his researches in electricity and magnetism.

17. The Laplace Prize, consisting of a collection of the works of Laplace, was bestowed upon M. Badoureau, pupil of the first rank, 1874, in the École Polytechnique, and student in the Ecole des Mines.

Several prizes were not awarded.

The following are the subjects proposed for the next competition:—

1. Grand Prize in the Mathematical Sciences for 1876:—To deduce from a new and thorough examination of ancient observations of eclipses the value of the apparent secular acceleration of the mean movement of the moon; to fix the limits of exactness which the determination bears. Value of the prize, 3,000 francs.

2. Another Grand Prize of the same value in the Mathematical Prizes for 1876:—Theory of the singular solutions of equations for partial derivatives of the first order.

3. Grand Prize of 3,000 francs in the Mathematical Sciences for 1877:—Application of the theory of elliptic or Abelian transcendentals to the study of algebraic curves.

4. Grand Prize of 3,000 francs in the Physical Sciences for 1876:—To investigate the changes which take place in the internal organs of insects during complete metamorphosis.

5. Another Grand Prize of 3,000 francs in the Physical Sciences for 1876:—Investigation into the mode of distribution of marine animals on the coast of France.

6. Grand Prize of 3,000 francs in the Physical Sciences for 1877:—Comparative study of the internal organisation of various Edraiophthalmous Crustaceans which inhabit the European seas.

7. Extraordinary Prize of 6,000 francs on the application of steam to war-ships.

8. The Poncelet Prize (annual), intended to reward the work most useful to the progress of the mathematical sciences, pure or applied, which will have been published during the last ten years. Value 2,000 francs, with a copy of the complete works of Poncelet.

9. The Montyon Prize (annual) of 427 francs:—Agricultural or Industrial Mechanics.

10. The Plumey Prize (annual) of 2,500 francs:—Improvements in steam-engines.

11. The Dalmont Prize (triennial) of 3,000 francs, to be awarded in 1876, is confined to engineers "des ponts et chaussées."

12. The Bordin Prize of 3,000 francs:—To find a means of doing away with, or at least of seriously diminishing the inconvenience and the dangers which arise from the products of combustion issuing from the chimneys of railway-engines and of steamboats, as well as in towns from the proximity of furnaces.

13. The Lalande Prize (annual) of 542 francs is offered to the work most useful to Astronomy.

14. The Damoiseau Prize (the value not indicated):—To review the theory of the Satellites of Jupiter; to examine the observations and deduce from them constants, particularly that relative to the speed of light; finally, to construct special tables for each satellite.

15. Vaillant Prize (biennial) of 4,000 francs, to be awarded in 1877, to the best work on the planetoids.

16. The Valz Prize (annual) of about 500 francs, to be awarded in 1877 to the author of the best charts relating to the region of the invariable plane of the solar system.

17. The Bordin Prize of 3,000 francs:—To determine the temperature of the solar surface.

18. The Montyon Prize (annual) of 453 francs:—Statistics of France.

19. One or more Jecker Prizes (annual) for works on Organic Chemistry.

20. The Barbier Prize (annual) of 2,000 francs, for a medical, surgical, or pharmaceutical discovery.

21. The Alhumbert Prize of 2,500 francs, to be awarded in 1876:—The method of nutrition of mushrooms.

22. The Desmazières Prize (annual) of 1,600 francs, for the best work on cryptogamy, published in the year which precedes that of the competition.

23. The Fons Mélicocq Prize (triennial) of 900 francs, to be awarded in 1877 to the author of the best botanical work on the North of France.

24. The Thore Prize (annual) of 300 francs, intended to reward alternatively researches on the cellular cryptogams of Europe, or on the habits and anatomy of an insect.

25. The Bordin Prize of 1876, of 3,000 francs:—To study comparatively the structure of the teguments of the seed in angiospermous and gymnospermous plants.

26. Another Bordin Prize for 1877, of 3,000 francs:—To study comparatively the structure and the development of the organs of vegetation in the Lycopodiaceæ.

27. The Morogues Prize (quinquennial), value not indicated, to be awarded to the author of the best work on Agriculture.

28. The Savigny Prize of about 1,000 francs is intended to reward a young zoological traveller.

29. The Bréant Prize of 100,000 francs, offered to whoever discovers the means of preventing Asiatic cholera or the causes of that malady.

30. Montyon Prizes (annual) in Medicine and Surgery.

31. Serres Prize (triennial) of 7,500 francs, for the best work on general embryogeny applied as far as possible to physiology and medicine.

32. Godard Prize (annual) of 1,000 francs, for the best memoir on the anatomy, physiology, or pathology of the genito-urinary organs.

33. Montyon Prize (annual) of 764 francs, in experimental physiology.

34. One or more Montyon Prizes (annual) in the industrial arts.

35. Trémont Prize (annual) of 1,100 francs, intended to encourage any *savant*, *artiste*, or mechanician who may be thought worthy.

36. The Geger Prize (annual) of 4,000 francs, "to support a poor *savant* who has signalised himself by important researches."

37. The Cuvier Prize (triennial) of 1,500 francs will be awarded in 1876 to the best work on the animal kingdom or on geology which will have appeared in the years 1873-75.

38. The Delalande-Guérineau Prize (biennial) of 1,000 francs, to be awarded in 1876 to the French traveller or *savant* who will have rendered the best services to France or to science.

39. The Laplace Prize (annual), consisting of a collection of the complete works of Laplace, to the pupil of first rank leaving the École Polytechnique.

The limit for the competitions for the above prizes is the 1st of June of the year in which the prize is to be awarded.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, June 17.—Dr. G. J. Allman, F.R.S., president, in the chair.—Mr. J. E. Howard, F.R.S., made some observations on *Cinchona anglica*, a hybrid between *C. Calisaya* and *C. succirubra*. Dr. Pryor exhibited specimens of *Myrsine Urvillei*, from New Zealand, which appeared to be hardy in this country.—The following papers were read:—1. On the affinities and febrifuge properties of the Aristolochiaceæ, by Mr. Clark.—2. On *Whitfieldia*, by Mr. S. Moore.—3. On the anatomy of *Amphioxus*, by Prof. E. R. Lankester, F.R.S. The author described the anatomy of *A. lanceolatus* as worked out in a series of sections made from numerous specimens collected by him at Naples. In opposition to Stieda, the truly perforate structure of the pharynx was asserted. A true body cavity or cœlom, distinct from the atrial chamber, was described, and it was shown to expand and attain a large development in the post-atrioporal region of the body. A pair of pigmented canals were described, apparently representing the vertebrate renal organ in a degenerate or else a rudimentary condition. Johannes Müller's pores of the lateral canals were shown to be hyoid slits leading into the pharynx. The attachment of the pharyngeal bars to the wall of the atrium by a series of pharyngo-pleural septa was minutely described. It was further shown that the marginal ridges of the ventral surface (metapleura) are hollow, containing a lymph-space, and that they, as well as the plates of the ventral integuments, disappear when the atrial chamber is largely distended with the sexual products. Drawings by Mr. W. J. Fanning, of Exeter College, were exhibited in illustration of the above statements.

Physical Society, June 26.—Prof. G. C. Foster, vice-president, in the chair.—Mr. W. J. Wilson read a paper on a method of measuring electrical resistance of liquids. Great difficulty has hitherto been experienced in measuring the resistance of electrolytes on account of the polarisation of the electrodes, and most of the methods hitherto employed have aimed at reducing this to a minimum by using large electrodes and very weak or rapidly alternating currents. The determinations, however, are difficult and require to be quickly performed. The following method is easy and is free from both the above objections. The arrangement in its most simple form consists of a long narrow trough filled with the liquid to be measured, say dilute acid. A porous pot containing a zinc plate in sulphate of zinc being placed in the acid at one end of the trough, and a similar pot with a copper plate in sulphate of copper in the acid at the other end, the whole arrangement forms a sort of elongated Daniell's cell, the chief resistance of which is in the long column of acid. The circuit between the plates being completed through a resistance box and mirror galvanometer, the current is shunted until a suitable deflection is obtained. One of the porous pots is now moved along the trough towards the other, and, as the resistance of the circuit is thus reduced by shortening the column of acid, the galvanometer deflection largely increases. The external resistance is now increased by means of the box, until the deflection is reduced to the same point as at first. This resistance put into the circuit is evidently equal to that of the liquid taken out, and thus a measure of the liquid resistance is obtained. Two forms of apparatus were shown. In one, the vessels containing sulphate of zinc and sulphate of copper respectively, formed pistons in a glass tube which contained the liquid to be examined. In the other, two pairs of concentric vessels were connected by a bent glass tube which contained the liquid under examination. The method is applicable to a great variety of liquids, and with care almost any degree of accuracy may be obtained. The chief obstacle to exact measurements lies in the fact that the resistance of liquids is greatly affected by temperature, but this difficulty is, of course, common to all methods. Mr. Wilson has been experimenting with brine, and gave some of the results obtained, but he has not as yet made a sufficient number of experiments to complete a table. A mode of arranging the apparatus in a differential or bridge form was also described, but it has not been found necessary to use it; the simple circuit arrangement giving accurate results with less trouble. Prof. Foster asked whether experiments had been made in order to compare this method with Wheatstone's, which differed from Mr. Wilson's, as *liquid* electrodes were not used. He then described an arrangement he had adopted for measuring the polarisation of plates in a voltameter. Prof. M'Leod stated that he had used plates of amalgamated zinc and reversed currents to overcome polarisation. He found that some salts, chloride of zinc for instance, had points of maximum conductivity which corresponded to a definite degree of concentration. Prof. Guthrie considered the research to be interesting as showing that points of minimum resistance might coincide with points of definite hydration of the salts.—Mr. Wilson, replying to Prof. Foster, stated tha tthe chief objection to the use of metal plates is not a variation of the electromotive force of polarisation, but the accumulation of bubbles of gas on the metallic surfaces.—Dr. Stone made a communication on the subjective phenomena of taste. He stated that some experiments he had recently made led him to consider whether there might be "complementary taste," just as there is "complementary sight." He described the following experiments as examples of the kind of phenomenon. If water be placed in the mouth after the back of the tongue has been moistened with moderately dilute nitric acid, the water will have a distinctly saccharine taste. Or if the wires from a 10-cell Grove's battery be covered with moist sponge, and placed one on the forehead and the other at the back of the neck, an impression is produced which is exactly similar to that resulting from the insertion of the tongue between a silver and a copper coin, the edges of which are in contact. Dr. Stone showed that the induced current usually employed for medical purposes has not this effect, and he considered the results curious, as, so far as we know, they can hardly be the result of chemical action. Mr. Roberts mentioned an instance in which sudden alarm had been followed by the peculiar taste which results from the introduction of two coins into the mouth, to which allusion had already been made.—Prof. Foster thanked Dr. Stone in the name of the Society, and expressed a hope that he would continue his suggestive and important experiments.—Four other communications were made, of which abstracts will be given in a future number.

Entomological Society, June 7.—Sir Sidney S. Saunders, C.M.G., president, in the chair.—Mr. Briggs exhibited some bred specimens of *Zygæna meliloti*, bearing a strong resemblance to *Z. trifolii*, and mentioned several instances in which the offspring of *Z. meliloti* exhibited a taint of *trifolii* blood, and suggesting that *Z. meliloti* might be only a stunted variety.—Mr. M'Lachlan exhibited a portion of a vine-leaf on which were galls of *Phylloxera vastatrix*, the leaf having been plucked in a greenhouse near London.—The Rev. A. E. Eaton exhibited the insects which he had recently captured in Kerguelen's Island. There were about a dozen species belonging to the *Coleoptera*, *Lepidoptera*, and *Diptera*, besides some specimens of bird-lice and fleas. They were all either apterous or the wings were more or less rudimentary. One of the *Diptera* possessed neither wings nor *halteres*.—Mr. Briggs exhibited a specimen of *Halias prasinana*, which, when taken, was heard to squeak several times distinctly, and at the same time a slender filament projected from beneath the abdomen was observed to be in rapid motion, and two small spiracles close to the filament were distinctly dilated.—The President called attention to a larva which he had recently discovered at Reigate in the body of a stylopised female of *Andrena trimmerana*, the larva having a long telescopic process at the anterior extremity, and two reniform processes behind, similar to *Conops*, an insect which had frequently been reared from *Pompilus*, *Sphex*, and *Odynerus*, and had also been met with in *Bombus*, although he had never before heard of its being found in *Andrena*.—The Secretary exhibited some specimens of a minute *Podura* forwarded to him by the Secretary of the Royal Microscopical Society, having been found on the snow of the Sierra Nevada in California.—Mr. F. H. Ward exhibited some microscopic slides showing specimens of a flea attached to the skin of the neck of a fowl.—Prof. Westwood communicated a description of a new genus of Clerideous Coleoptera from the Malay Archipelago.—Mr. M'Lachlan read a paper entitled "A sketch of our present knowledge of the Neuropterous Fauna of Japan (excluding the *Odonata* and *Trichoptera*)."

BERLIN

German Chemical Society, June 14.—A. W. Hofmann, president, in the chair.—The President opened the proceedings by informing the Society that their veteran honorary member, Prof. Wöhler, had very kindly written some recollections of his life for the special purpose of being read to the meeting; refusing, however, their publication in the Proceedings of the Society. The following short extracts of these "recollections of an old chemist" will give some idea of the interest attending the MS. read by the President. On the 2nd of September, 1823, Dr. Wöhler had finished his medical studies at Heidelberg, and, yielding to the advice of L. Gmelin, he abandoned the plan of practising medicine, took up chemistry as the aim of his life, and repaired to Stockholm as a pupil of Berzelius. Choosing the route from Lübeck by sea, he was obliged to wait six weeks for the departure of a boat. The tedious stay in that harbour was shortened through the acquaintance of a mineral dealer already known to Wöhler from the Frankfort fair, where he had exchanged hyaliths for other minerals, and where Wöhler had met Goethe bent upon a similar errand. He also made the acquaintance of a pharmaceutical chemist, Mr. Kind, at Lübeck, and with him prepared potassium in quantities hitherto unknown in Germany, and which, later on, Berzelius made use of in his studies of boron and silicium. Arriving after a stormy passage, he managed to find his way, by the aid of a Swedish student, with whom he had to talk Latin, the only language they had in common. He trembled almost at the first interview with the celebrated chemist, but was soon put at ease by his genial manner. Berzelius's laboratory was of the simplest. It consisted of two bare rooms and of a kitchen, which served at the same time for cooking the meals of the bachelor-household. This was the time when Berzelius had just adopted the chlorine theory. An old maiden cook who reigned supreme at the hearth complaining one day of the smell of "oxidised muriatic acid," Berzelius exclaimed, smiling, "There is no longer any oxymuriatic acid, Anna; you must say it smells very badly of chlorine." To try his pupil's patience, he put him to the analysis of lievriete, demanding great exactness. When the analysis did not come up to the mark, he said: "Doctor, that was quick, but bad." But soon he took the greatest interest in his pupil's researches on cyanic acid, for which the ferrocyanide of potassium had to be sent for from Lübeck. Berzelius kept his simplicity in his intercourse with the courtiers who sometimes visited the laboratory, and for whom some interesting experiments had to be performed. He was an excellent narrator, and Wöhler listened with the greatest interest to his recollections of Gay Lussac and of Sir Humphry Davy. Wöhler passed a very busy winter, spending his evenings in translating Berzelius' annual reports and Hisinger's treatise on mineralogy. When the spring came he enjoyed walks in the beautiful neighbourhood of Stockholm, studded with the last oaks of the northern zone, and he became intimately acquainted with the Swedish philosophers Caro, Mosander, Retzius, Arfvedson, Hisinger, and others who have now all left the scene of life. At last the time arrived when he had to take his departure from Sweden, and he did so, accompanied by Berzelius himself, who had invited him to take a journey through Sweden and Norway. Many mineral treasures were collected on the road, and the great mines and industrial establishments were visited. At Helsingborg the travellers stopped for several days to wait for the arrival of Brogniart, father and son, the French geologists, and of Sir Humphry Davy. The latter was then salmon-fishing in Norway, and announced his arrival to Berzelius in a letter commencing, "My dear sir and very honoured brother in science." He had some kind and encouraging words for young Wöhler, not forgotten by the latter in his celebrity and his old age. Sir Humphry soon left for Copenhagen, where he had an engagement to shoot snipe with Forchhammer. Oerstedt arrived also to pay Berzelius his respects, and so did several professors from the neighbouring university of Lund. In fact, Berzelius's celebrity was so great that an official in the passport office refused to take any fee from the pupil who had come to study under such a master. Messrs. Brogniart had taken their comfortable travelling carriage over from Paris. Their comfort, however, was disturbed by the arrival of a French courier, the bearer, as they feared, of news of Louis XVIII.'s death. Putting the question to the courier, they received the answer, "Messieurs, vous savez, qu'un courier doit être aveugle, sourd et muet." The journey to Norway was continued in common, the elder Brogniart and Berzelius occupying the carriage of the former, Wöhler and the younger Brogniart following in Berzelius's carriage. They often had to stop all night in their carriages; for it so happened that the Crown Prince preceded them on their road with a numerous suite, and the inns were overcrowded. We cannot enter into the details of this interesting journey. When it came to a close at Helsingborg, Wöhler had to take leave of his master, and the feelings of regret were mutual and deep. Translating Berzelius's reports and his handbooks became henceforth a duty to Wöhler, by which, regardless of the time it demanded, he tried to repay a debt of gratitude. The meeting sent a vote of thanks to the great and modest author of these recollections, praying for his permission to print them in the Society's Reports; and your correspondent hopes he may be forgiven any indiscretion he has been guilty of in preserving for the scientific world these short extracts.—Th. Zoeller and E. A. Grothe have introduced xanthogenate of sodium as a remedy for Phylloxera. Compared with the sulfocarbonate of sodium, it deserves the preference. $CS\begin{smallmatrix}SNa\\SNa\end{smallmatrix}$ is easily transferred into CS_2 and HS_2, the former killing the Phylloxera, while the latter gas injures the vine; but xanthogenate of sodium, $CS\begin{smallmatrix}SC_2H_5\\ONa\end{smallmatrix}$, cannot produce hydrosulphuric acid, and appears to be by far the better remedy of the two, as well as the cheaper one.—S. Reymann proposes the following way of determining the amount of orcine contained in lichens. Bromine-water of known strength is added to the solution, producing tribromorcine, $C_7H_5Br_3O_2$, until the solution has a permanent smell of bromine. Iodide of potassium is then added, and the amount of iodine set free (corresponding to the excess of bromine added) is determined by volumetric analysis.—The same chemist described an easy method of determining the quantity of bromoform contained in commercial bromine.—E. Donath described a method of extracting from yeast a substance inverting cane-sugar, and called by him invertine.—E. Zuercher has found bromonitroæthan to be transformed by nitrite of potassium and alcoholic potash into yellow needles of potassic dinitroæthan:

$$\begin{array}{l}CH_3\\ |\\ CH(NO_2)Br\end{array} + KNO_2 + KOH = \begin{array}{l}CH_3\\ |\\ CH(NO_2)_2K\end{array} + KBr + H_2O.$$

The substance resembles the corresponding picrate. The acid is an oily liquid.—E. Forst and Th. Zincke have oxidised the two isomeric glycols, hydrobenzoine and isohydrobenzoine, $C_{14}H_{12}(OH)_2$. Both yield benzoic aldehyde. The authors try to explain the identity of these reactions by constitutional formulæ.—F. Tieftrunk exhibited specimens of gas-tight membranes, invented by Mr. Schülke, and used for a new system of dry-meters by Mr. S. Elster in Berlin. The membranes are not acted upon by hydrocarbons, sulphuret of carbon, or ammonia, and form a much better material for dry-meters than leather. Mr. Tieftrunk demonstrated another application of this invention, consisting in a gas-burner yielding a constant flame. An air-bath heated with this burner did not vary in temperature more than one degree during six hours.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Differential and Integral Calculus: C. P. Buckingham (Trübner and Co)—Italian Alps: Douglas A. Freshfield (Longmans).—An Analysis of the Life Form in Art: Dr. Harrison Allen (Trubner and Co)—Nuragghi Sardi and other non-historic Stone Structures of the Mediterranean Basin: Capt. S. Pasfield Oliver, R.A., F.S.A, F.R.G.S. (Dublin, Carson Bros.)—Proceedings of the Royal Society of Edinburgh, 1874-75.

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THURSDAY, JULY 8, 1875

HOLLAND'S "FRAGMENTARY PAPERS"

Fragmentary Papers on Science and other Subjects. By the late Sir Henry Holland, Bart. Edited by his Son, Rev. Francis J. Holland. (London: Longmans, 1875.)

IT is impossible not to be struck with the width of knowledge, the balance of intellect, and the true wisdom shown in the posthumous writings of the late Sir Henry Holland. This distinguished physician was born as long ago as 1788, when many of the most extensive and important sciences—Chemistry, Electricity, Heat, Geology, and others—could hardly be said to exist. Yet we find in these papers that he was fully alive to discoveries which were quite recently made. Not only does he appear to have accepted the Evolution Philosophy in a thorough-going manner, and to have acquired a perfect comprehension of its bearings and results, but the latest discoveries in each branch of physical science were familiar to him, and duly considered in retouching his papers for the last time. Writing in 1873 at the age of eighty-five, he naïvely remarks that it would be impossible at his age to re-write the whole of his essays so as to bring them up completely to the present day. He therefore proposed to select what was most suitable for publication, making such additions as were suggested by the recent progress of research.

The essays, as now published, range over most of the physical and moral sciences, and touch upon theology. The Plurality of Worlds, Creative Power, Matter and Force, Divisibility of Matter, the Nature of Electricity, Animal Instincts, the Perfectibility of Man, Infinity, Eternity, Materialism, Scepticism, Subjective Functions of the Eye, Sleep and Dreams,—such are only a part of the topics upon which he discourses. It is, of course, out of the question that an old man writing between the seventieth and eighty-fifth year of his age could give much that is original and novel upon such a wide range of subjects. Of this he must have been fully conscious, and his object appears rather to have been to sum up the results of the progress of science as he had witnessed that progress, and to point out how far it had really gone in comparison with the possible sphere of discovery. His principal conclusion is, that no efforts of scientific men have yet, or indeed ever can, penetrate the mysteries of existence. His favourite expression is that of Laplace: "Notre ignorance est immense."

He more fully states his convictions in the following words:—

> "The horizon of our knowledge continually, though unequally, expands—obscure in its boundary on every side, and ultimately defined by limits impassable to human reason. One man by genius or happy accident may press more closely than another towards this horizon; but the ultimate limit is the same to all, involving those mysteries of matter, force, and creative or governmental power, to which all other problems are subordinate."

One of the most original and interesting essays is that in which Sir Henry Holland treats of "mental operations in relation to time." The same subject had, indeed, been discussed in two chapters of his "Mental Physiology," and he had shown how many striking illustrations of the relations of states of mind in succession, one to the other, may be discovered. He wished to see carried out an experimental inquiry into the chronometry of mind, by observing the velocity with which trains of ideas can be made to move through the mind in various circumstances. The following is an example of the kind of self-experiment which Sir Henry tried (p. 106):—

> "Within a minute I have been able to *coerce* the mind, so to speak, into more than a dozen acts or states of thought, so incongruous that no natural association could possibly bring them into succession. In illustration I note here certain objects which, with a watch before me, I have just succeeded in compressing, *distinctly and successively*, within thirty seconds of time—the pyramids of Ghizeh, the Ornithorhynchus, Julius Cæsar, the Ottawa Falls, the rings of Saturn, the Apollo Belvedere. This is an experiment I have often made on myself, and with the same general result. It would be hard to name or describe the operation of mind by which these successive objects have been thus suddenly evoked and dismissed. There is the volition to change; but how must we define that effort by which the mind, without any principle of selection or association, can grasp so rapidly a succession of images thus incongruous, drawn seemingly at random from past thoughts and memories? I call it an *effort*, because it is felt as such, and cannot be long continued without fatigue."

This is a curious subject which easily admits of experiment; but it will be found that the velocity with which thoughts can be made to succeed each other depends entirely upon the degree of similarity or connection between them. Judging from my own experience and that of three students, well qualified to test the matter, I find that where the objects thought of are as incongruous as possible, the number which the mind can suggest to itself in a minute varies from twelve, the result of Sir Henry Holland, up to about twenty. Anyone who tries the experiment, however, will find that there is an almost insuperable temptation to go off on lines of association. To avoid these and yet to think rapidly, requires a very disagreeable effort, becoming more and more painful by repetition.

When the thoughts are restricted within certain grooves, as it were, the result is more rapid succession. Thus one student was able to think in a minute of thirty different kinds of actions, forty-six animals, fifty places, or fifty persons. I can myself think without much effort of thirty-two animals, or forty persons or places in a minute. Even in these cases, however, it will be found that the rapidity greatly depends upon the degree in which the objects have been associated. When thoughts have been very closely and frequently linked together, the number which may be compressed within a minute is much greater. I find that I can count about ninety-six in half a minute, which, without allowing for the two places of figures, gives 192 thoughts per minute. I can think of every letter in the alphabet in five seconds at most, which is at the rate of more than 300 per minute. Finally, by counting the first ten numbers over and over again, I have compressed nearly 400 changes of idea within the minute. Thus it may be said that the facility of mental action varies something like forty-fold, according to the degree of previous association between the ideas.

Little has hitherto been done to investigate the action of mind systematically, but there is little doubt that by following up the hints given by Sir Henry Holland, Prof. Wendell Holmes, and some others, useful results might be obtained. It is difficult to help agreeing with Sir Henry when he remarks that the opinions of Comte on this subject are a sheer paradox (p. 97). Comte strangely denied the competence of consciousness as an interpreter of mental functions. It may perhaps be allowed that consciousness has not been happily investigated hitherto, but it would be wholly premature to assert that it is incapable of scientific investigation.

W. STANLEY JEVONS

URE'S "DICTIONARY OF ARTS"

Ure's Dictionary of Arts, Manufactures, and Mines. By Robert Hunt, F.R.S., Keeper of Mining Records, &c., &c., assisted by F. W. Rudler, F.G.S., and by numerous contributors eminent in science and familiar with manufactures. Seventh edition, in three volumes. (London: Longmans, 1875.)

THIS well-known work, of which the seventh edition is now before us, first made its appearance in the past generation. During the life-time of its original projector and editor, Dr. Andrew Ure, it undoubtedly contributed largely to advance the education and progress of our manufacturing and industrial classes, and well-thumbed copies of it are to be found on the library shelves of all the "Mechanics' Institutions" which the educational revival of thirty years ago scattered over the land.

We find from the preface that since 1858, when the present editor took charge of the work, three editions, including the present, have appeared, so that its reputation as a standard work of reference appears to be still maintained.

In the volumes now before us, there are, as might be expected, great differences from the edition which preceded them, many new industries having arisen, while others, if they have not altogether disappeared, have at least lost much of their importance. The alterations thus arising have overpassed the space left available by the curtailment and omission of some of the articles which had lost their value, and have increased the size of the work to a total of 3,255 pages for the three volumes. Although a long list of contributors succeeds the preface, we imagine that the burden of the major part of this increase must have fallen on the two editors, and it is therefore with considerable pleasure that we congratulate them on the thorough manner in which the revision has been effected, and the very full and complete information given in nearly all cases. We must not, perhaps, complain if the information given in such articles as "Alizarine" and "Aniline" is not very full, since the complete knowledge of the actual methods of production employed in these and in other cases of chemical manufacture are in the possession of persons whose interest it is not to be very explicit in matters involving manufacturing secrets. While, however, the editors are to be praised for keeping the articles abreast of the time in other respects, we cannot agree with them that it is good policy to retain, as they have done, the old equivalentic formulæ beside the atomic ones which are now, and have been for years past, in such general use as to justify the exclusion of the former altogether, as has been done in every other work on chemical subjects printed within the last five years. The acquisition of the modern views and system of formulæ is really so simple a matter that there is no justification for its not being made by everyone interested in the science, and the retention of both forms tends to confuse young workers while conferring at best a doubtful benefit upon those who, having learnt the older form, are not made to feel the necessity of learning the newer.

As may be supposed from the names of the editors, the parts relating to mining and metallurgy are extremely full of valuable information, and we notice particularly an article on coal-cutting machines, one on safety apparatus for mines, and one on mine-ventilation, as deserving attention. Much information is given on printing, and the mixed chemical and mechanical art of calico printing is most exhaustively treated. In the article on the soda manufacture, a good sketch of Schlœsing and Rolland's process is given. The explanation of the devitrification of glass, given in vol. ii. p. 647, is, however, only probably true in a limited number of cases, in many the change being molecular only, and not involving the formation of definite silicates.

The article on coal-gas is particularly full and well written; but in fact this may be said of so many of the subjects treated that it becomes an invidious task to attempt to point out the shortcomings which are in some cases unavoidable in a work of this magnitude, while it is a pleasant one to congratulate Messrs. Hunt and Rudler on the care and ability bestowed on a task of great difficulty. We have only to add that the type of the work has been entirely reset, and the titles of the articles printed in a bold type which renders reference easy.

R. J. F.

DRUMMOND'S "LARGE GAME OF SOUTH AFRICA"

The Large Game and Natural History of South and South-east Africa. From the Journals of the Hon. W. H. Drummond. (Edinburgh: Edmonston and Douglas, 1875.)

THE countries of Amazulu, Amatonga, and Amaswazi form the tract of land bounded on the south by Natal, and on the west by the Transvaal Republic. These were the scenes of Mr. Drummond's experiences, which, he tells us, extended over a period of some five years, ending in 1872. He candidly admits that his knowledge of Natural History as a science is little or nothing, in consequence of which all reference to questions bearing on the subject are omitted, except those which have come within his personal knowledge. Such being the case, we think that we cannot do better than make an attempt to summarise the direct information which the author places before us on those biological questions which are in any way referred to, leaving the discussion of the many valuable observations on sport in general to contemporaries who are in the habit of keeping those subjects in constant view.

Of the nine chapters which constitute the work, the first six treat of the buffalo, rhinoceros, eland, elephant, lion, and leopard; the remaining three being devoted to anecdotes connected with dogs, antelopes, and game birds.

Respecting the first of these animals, the statement that "only one species of buffalo (*Bubalus caffer*) is found in the southern part of Africa," is confirmatory of the results arrived at by all other investigators. Their abundance and ferocity when charging are much emphasised.

Our knowledge of the African rhinoceroses is much more imperfect than that of their Indian allies, and Mr. Drummond's remarks on these animals must be looked upon as those of a reliable and acute observer. We read: "As far as my experience and inquiries have gone, I believe, in accordance with the recorded opinions of most travellers and sportsmen who have given any attention to the subject, that there are four—two of the so-called 'white,' and two of the 'black.'" The way in which these four species are arrived at, presents one point, at least, of special interest. The first species is the *Rhinoceros bicornis*, "borele" or "upetyane," the smallest and most dangerous of the four, it alone being in the habit of attacking man unprovoked. The second is the *R. keitloa*; the "keitloa" or "umkombe tovote," the next largest, with the hind horn, which is quite small in all the others, very nearly as big as, or even sometimes bigger than, the fore one. In one specimen "the horns, which were unusually good, measured twenty-four inches for the front one, twenty for the back." The third species is the *R. simus*, "umkave," or common white rhinoceros, the largest of all; it is "remarkable for the great length the front horn grows to, as well as for its gentle and inoffensive disposition." With this is united as a variety *R. oswellii*, in which the front horn is particularly long and turns forwards; and we are well disposed to agree with Mr. Drummond in thus laying little or no stress on peculiarities in the horns when they are not associated with other characters. For a knowledge of the last species we have to rely entirely on our author. It has an independent native name, which is in its favour, being known as the "Kulumane." It "differs from the other species (*R. simus*) in three important particulars: firstly, in its horns, which, though following the conformation of *R. simus*, never attain to the same size; secondly, in its measurements, which, while considerably inferior to those of the common white, are greater than those of the other two species, while it is to be noted that it possesses, though in a less marked degree, the long and prehensile upper lip which characterises *R. bicornis* and *R. keitloa*; thirdly, in its food, for though preferring, as was to be expected from the formation of its snout, the young tender shoots and leaves of thorns, it also resembles *R. simus* in consuming large quantities of grass. In its disposition it would seem to combine the characteristics of the other species."

The author was fortunate enough to capture and keep alive for a short time a very young individual of the last-described species, and he tells us that "if a specimen were really wanted for this country [which most certainly is the case], and there is not a single one as yet, I have no doubt that the difficulty of finding a substitute for its mother's milk —a serious one in a land where cattle do not exist on account of the tsetse—might be got over by the sacrifice of the lives of a few cows, for, as the bite of this insect does not cause immediate death . . . they might be brought down to the plains, and would probably live long enough to take the young rhinoceros to the higher districts, where plenty of milk could be procured." It is much to be regretted that Mr. Drummond was not able to employ the method he thus describes so clearly, and so put us in possession of an invaluable zoological treasure.

The light thrown on the question as to whether the striped eland is a species differing from the unstriped animal is but small, the author's experience being in favour of there being but one. Both varieties are met with in Amatonga. As to the elephant, its difference from its Asiatic brother in the conformation of its skull produces an important difference in the hunter's point of view also. In the Indian species "the forehead presents a certain mark, while in Africa it is quite impervious." The following observations will also be read with painful interest. "Slowly, but surely, this most useful animal is being extirpated, merely for the purpose of supplying Europe with ivory ornaments and billiard-balls, and before many years are over the inhabitants of Africa will grieve, when it is too late, at the short-sighted policy which has allowed them, for the purposes of immediate gain, to kill down the only animal capable of becoming a beast of burden through the tsetse-infected districts of that continent." The extreme difficulty of taming the animal, the impossibility of breeding it in captivity, and the rapid advance in steam-locomotive power, must, however, be placed in the balance against the advantages which the creature offers.

The portion of the work devoted to the lion and the leopard abounds in incidents, many of which terminated fatally; so many, indeed, that we can hardly understand how it is that the author places the upetyane (*Rhinoceros bicornis*) before the lion in comparing the different shades of danger encountered from the larger varieties of South African animals.

In conclusion, we strongly recommend this book to all who are fond of sport and who require practical hints on minor details before commencing a similar undertaking. To the student of Natural History it will be equally attractive, because of the clear and pleasing manner in which it depicts the manners and habits of several animals in their native haunts, nothing respecting which can be gained from any amount of study of the dry skins or skeletons. It is by his knowledge of the habits of the creatures which he is accustomed to meet, that the practical naturalist can frequently put the museum-student to shame, and for this reason we think that works like the one before us ought to be studied by zoologists.

Some of the illustrations are good, but many of them are quaint and not always accurate. Why the head of a Zebra introduces the chapter on the Eland, and an Aard Wolf does the same with respect to the Leopard, we are at a loss to understand.

BRUSH'S "DETERMINATIVE MINERALOGY"

Manual of Determinative Mineralogy, with an Introduction on Blowpipe Analysis. By George J. Brush, Professor of Mineralogy in the Sheffield Scientific School. (New York: John Wiley and Son, 1875.)

PROF. BRUSH has endeavoured to make the study of mineralogy lighter than usual, and has in many respects succeeded, but unfortunately for the modern student he has retained the old chemical formulæ. Surely it would have been better to swim with the times and adopt the new atomic weights, taking care to abolish all doubtful tests, and adding the latest and most accurate methods of analysis. Many of the latest and most delicate methods of mineral analysis are entirely omitted, such as Bunsen's methods for the detection of arsenic, antimony, selenium, molybdanum, uranium, &c. The work in question is divided into two distinct parts; the first containing descriptions of the different apparatus and reagents used, and a "Systematic Course of Blowpipe Analysis;" the second, styled "Determinative Mineralogy," makes use of the knowledge acquired in the first part to determine the mineral species under examination. The "Systematic Course of Blowpipe Analysis" is adapted from the later editions of Plattner's work on Blowpipe Analysis, edited by his successor, Prof. Richter; the "Determinative Mineralogy" is a translation of Von Kobell's "Tafeln zur Bestimmung der Mineralien," tenth edition. Generally speaking, students do not take kindly to "Tables," but Prof. Brush has made them more inviting by arranging the minerals having the same base into groups, and studying them in order. This is an excellent arrangement, and the distinguished author deserves the gratitude of students for thus lightening their labours. Too many mineralogical works of the present day exhibit a harum-scarum kind of classification, which simply bewilders the inquiring student and leaves him in greater confusion than before. The first part of the work opens with descriptions of various kinds of blowpipes, and the manner of using them, also the fuel used to obtain the requisite flame. Here, under the headings "Reducing" and "Oxidising" flames, are described very clearly the characters of the two flames, with very good engravings showing the zones. The methods for preparing the various reagents required are trivial and should have been omitted; for instance, we are told to prepare pure carbonate of soda by taking "four or five ounces of *commercial* bicarbonate of soda *free from mechanical impurities*," &c. We should be glad to know where Prof. Brush obtains his commercial bicarbonate of soda so free from impurity, as the manufacturer deserves encouragement. Chapter II. commences the "Systematic Course of Qualitative Blowpipe Analysis," describing the reactions of the elements and their combinations in the "closed tube and open tube," and on "Charcoal as a support." Under the latter heading a very neat and novel method is given for overcoming the great difficulty experienced sometimes in keeping the assay in its place on the charcoal. Let those who wish to work in comfort for the future buy the book, and find the method therein.

Further on, the colours imparted to a flame by different metallic salts are described, but all of them, with the exception of copper, sodium, potassium, lithium, and calcium, might have been left out with perfect justice, for no one could decide what metal was present from a simple examination of the coloured flame as described; that could only be done by means of the spectroscope. Then follow "The uses of Fluxes and Roasting," and "Fusion with Borax," which are simply adaptations from Plattner, and the tables given in this division are literal translations from the same author, which may also be said of the division "Fusion with Salt of Phosphorus." It is only fair to say that in the preface to his book Prof. Brush states: "The main authorities used in the original preparation and later revision of the chapters on blowpipe analysis were the works of Berzelius and Plattner. The third and fourth editions of Plattner, the latter edited by Prof. Richter, have been chiefly consulted." The whole work seems to confine itself almost entirely to blowpipe analysis by the dry method, ignoring very frequently much easier and quicker methods of detection by the wet method of analysis. A few instances may be given, viz., copper when associated with nickel, cobalt, iron, and arsenic by the dry method, proceed as follows:—"Separate *most* of the cobalt and iron by treating with borax on charcoal, the remaining metallic globule is fused with pure lead, and then boric acid is added; this last dissolves the lead and the rest of the cobalt and iron, while most of the arsenic is volatilised. The cupriferous nickel globule which still may contain a little arsenic is treated with salt of phosphorus in the oxidising flame; the bead obtained will be dark green while hot, and clear green when cold. This last green is caused by a mixture of the yellow of oxide of nickel and the blue of oxide of copper." What a complicated and tedious process! Now let us consider the wet method well known to chemists, but not mentioned amongst the "characteristic reactions" in the first part of this book. Dissolve the mineral in nitric acid or nitro-hydrochloric acid, get rid of the excess of nitric acid, precipitate the copper by means of sulphuretted hydrogen, dissolve this precipitate in nitric acid, and add excess of ammonia, when the liquid at once acquires the splendid well-known blue colour. The arsenic will be present as arseniate of ammonia, and will not interfere with the reaction. Even more easily can traces of copper be detected by Bunsen's neat method, as follows:—Fuse the assay on a charcoal match with carbonate of sodium in the reducing flame, treat the fused mass with distilled water in a porcelain basin, gather together (by means of a small magnet) the metallic particles of cobalt, nickel, and iron, and remove them; dissolve the remaining metallic copper in nitric acid; take up a drop of this solution by means of a glass rod and place it upon a strip of white filter-paper, add a drop of ammonia to the moistened paper, and observe the decided blue colour where the drop of solution was placed. Thus, by the time the student had blundered through the dry method of discovering copper, a skilful chemist would almost have determined the percentage of copper present in the assay by some volumetric process. Singularly enough, the above method is mentioned several times *incidentally* in the second part, entitled "Determinative Mineralogy." Under the heading "Iron," no mention is made of the well-known reaction between ferric salts and ferrocyanide of potassium, but doubtful borax bead reactions are very prominent. The characteristic precipitate obtained by mixing soluble lead salts with bichromate of potassium is omitted also. Chapter IV. opens with "Determinative Mineralogy." These tables are the best part of the book. The student must be very dull indeed who fails to determine a mineral by the use of them. The method of studying the different minerals is excellent, as the specimen under examination is soon brought into a group; and by glancing at the characteristics of each mineral in that group, and comparing the reactions obtained with the specimen, the name is ascertained without difficulty. An example will suffice to show this:—"The mineral has a metallic lustre. Its degree of fusibility is 2, and a portion of it is readily volatile, evolving the garlic-like smell peculiar to arsenical minerals. On looking at the tables it is found to belong to Division I. Fused with carbonate of sodium on charcoal in the reducing flame, no metallic globule is obtained, but the reaction for sulphur is seen on moistening the fused mass and placing it upon a piece of silver. Does not give the reactions for copper or cobalt. In the closed tube gives metallic arsenic, and after long heating becomes magnetic. It is found that it can only be one of two minerals, viz., Arsenopyrite (mispickel) or Lölingite. The streaks, colour, and hardness are the same; but two reactions observed before prove it to be arsenopyrite, for it fuses at 2, and gives a strong sulphur reaction." As we have pointed out, it might have been expected that so distinguished a mineralogist as Prof. Brush would have given us all the more modern methods, but, nevertheless, his book is certainly a very useful one, and may be recommended to the student. CHARLES A. BURGHARDT

OUR BOOK SHELF

Elementary Chemistry. By F. S. Barff, M.A. (London: Edward Stanford, 1875.)

THE question which naturally occurs to one on opening this book is, Why was it written? Of late we have had so many books professing to teach elementary chemistry, and some of these really fulfilling their profession, that it is hard to understand why another should be added to the list. In his preface the author says: "This book, as far as it goes, professes to enable the attentive student to acquire a sound knowledge of the very elementary facts concerning the most important of the 'non-metallic elements,' as they are called." Again, he expresses the belief that by the system he has adopted, "boys will have their reasoning faculties strengthened and their powers of observation rendered accurate and acute."

So far as mere facts are concerned, this book appears to to be very trustworthy; the author is evidently well acquainted with his subject; but there is a want of principles to guide the student. If chemistry is to be taught thoroughly, even in its elements, the method of teaching adopted must from the very beginning be a scientific method; it must seek not only to inculcate accuracy of knowledge in detail, but also to point out the generalised expressions which bind together the facts into a connected system. By studying the book before us a boy may certainly gain a considerable amount of good and useful knowledge, but we are afraid that his ideas of what chemical science is will be at best but vague. The author does not appear to have clearly set before himself the end which he desired to secure by writing a book on elementary chemistry. If that end was merely to supply a collection of useful facts about various chemical substances and processes, he has succeeded; but books already existed which supplied this want. If he wished to supply sound chemical knowledge, *so far as the book goes*, he must be said also to have succeeded, but unfortunately he has stopped too soon; the fault is that it does not go quite far enough: a little more carefulness in planning the book, and the introduction of at least a few generalisations to explain the facts, would have added vastly to the value of the book as an elementary educational work. If we compare this little book with others which might be named which cover much the same ground, the want of general ideas to guide the student becomes very apparent. Another question which occurs in connection with a book on chemistry specially intended for the use of boys at school is, Are schoolboys as a rule really interested in this science? Is it found generally advisable to devote any large portion of a schoolboy's time to the study of chemistry; or is it better, when natural science is introduced into a school curriculum, to choose physics as the principal subject-matter for study?

M. M. P. M.

Travels in Portugal. By John Latouche. With Illustrations by the Right Hon. T. Sotheron-Estcourt. (London: Ward, Lock, and Tyler.)

MR. LATOUCHE'S narrative is full of interest and instruction; but why has he not indicated the year or years during which he travelled in Portugal? There is even no date on the title-page. We hope Mr. Latouche will supply the necessary dates in a second edition. The author refers with justice to the general ignorance of Portugal and of its people; many, no doubt, suppose they are a sort of degraded Spaniards, whereas we think it is pretty clear, from the information contained in the work before us, that the Portuguese are in many respects superior to their neighbours. Mr. Latouche evidently knows Portugal well, and has carefully observed the characteristics of its people. In his narrative he wisely gives very few details about the beaten tracks, but describes principally what he saw in districts which are never visited by the ordinary traveller. His work contains much information concerning the people, their ethnology, language, manners, customs, superstitions, and history; about the country itself, its physical features, its natural history, the state of agriculture, and other points of interest. As to the ethnology of Portugal, Mr. Latouche seems to believe that the people are an agglomeration of a greater variety of elements than that of any other country in Europe, and that these elements still remain to a large extent heterogeneous, different elements preponderating in different districts—Celts, Iberians, Phœnicians, Romans, Visigoths, Saracens, Greeks, French, and Jews all contributing their quota. As an illustration of the extensive infusion of Jewish blood throughout all ranks of the people, Mr. Latouche tells the following anecdote:—"When that foolish bigot, King Joseph, proposed to his minister Pombal that all Jews in his kingdom should be compelled to wear white hats as a distinctive badge, that sagacious minister made no objection, but when next he appeared in Council it was with two white hats—'one for his Majesty and one for himself,' explained Pombal, and the King said no more about his proposal." With regard to the natural history of Portugal, Mr. Latouche thinks there is much still to be learned; that, in fact, it has been less studied than that of any other country in Europe. There is no doubt much truth in this, but we hope it will not be necessary for any foreign "patient naturalist" to learn the language, as Mr. Latouche suggests, in order to investigate the natural history of Portugal. Surely there is a sufficient number of competent men in the country itself to undertake the task, if their attention were directed to the importance of having it accomplished. Indeed, we believe there have not been wanting signs recently of an awakening of intellectual life in Portugal, and we hope that one of its results will be a thorough investigation of the natural history of the country, as well as a vast improvement in the wretched system of education which prevails. The Portuguese, as our readers know, were at one time one of the most enterprising people in Europe, and under proper guidance might still occupy an honourable position among the nations.

To those who wish to obtain some trustworthy information concerning the present condition of Portugal, we commend Mr. Latouche's work, which, we may state, is enlarged from a series of articles which were published in the *New Quarterly Magazine*.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts, No notice is taken of anonymous communications.*]

Temperature of the Body in Mountain Climbing

I HAVE read with great interest the able paper on the Temperature of the Human Body during Mountain Climbing in NATURE, vol. xii. p. 132, and as it is there mentioned that the results obtained by Drs. Marcet and Lortet require confirmation, I am tempted to send some extracts from notes of observations made on myself while on a walking tour last autumn, in the Yorkshire moors. I made in all five ascents, of heights over 2,000 feet, during all of which I took notes of my temperature at intervals. As, however, I had no more than a hearsay acquaintance with Dr. Marcet's results, and was not aware of the important influence of the act of ascending as distinguished from the elevation attained, my earlier results were not sufficiently connected to be worth publishing. Suffice it to say that I always obtained a fall of from one to two degrees. On the fifth day of observation, when I was alive to this and other sources of error, I made the following observations in the course of the ascent of Whernside and Gragreth.

	Time.	Height in feet.	Temperature in mouth.
In bed, Chapel le Dale, feeling warm	7.30	900	97·7
Breakfast	8.30	—	—
Before starting, feeling cold	9.40	—	97·6
Walked one mile nearly level ; spent half an hour at Gate Kirk Cave, then a steep ascent ; after rising 1,000 feet and while hot, tired, and sweating, and before stopping	11.20	1,900	96·4
Sat down ; after ten minutes' rest felt fresh, and neither hot nor cold	11.30	—	98·2
Ascent continues steep till near the top, when it is moderate ; reached the top hot, sweating, and out of breath ; temp. of air 47°, barometer 27·4 in.	12	2,414	97·6
After sitting still in a cold wind and eating 4 oz. biscuits ; toes and fingers cold, and shivering slightly	12.37	—	99·3
Steep descent of 1,000 feet, came down at a run ; fingers and toes getting warm ; before stopping	1.10	1,400	98·0
Crossed the valley to ascend Gragreth ; after climbing 500 feet, sweating and feeling hot, and before stopping	2.17	1 900	96·4
After sitting seven minutes	2.24	—	97·6
Still sitting, feeling cooler	2.29	—	98·6
Still sitting	2.33	—	98·6
Nearly at the top	2 47	2,200	98
On the flat top of Gragreth, going slower, feeling cooler	2.52	2,250	98·2
Sitting, feeling cold, strong wind...	3.12	—	98·4
After descending 1,050 feet rapidly	3.55	1,200	98·4
After sitting ten minutes...	4.5	—	98
Sitting warm, at "George and Dragon" Inn, Dent...	9.50	500	97·9

In comparing the temperatures above it should be borne in mind that I uniformly found my temperature in bed in the morning 97·6 or 97·7, and about the same at 9 or 10 at night ; while the day previous, when detained in the house by bad weather, it had been 98·4 and 98·6 in several observations, between 10.30 A.M. and 6 P.M., and this I have found the case on many other occasions, so that the difference between the second and third observations really represents a greater depression than is apparent.

It is worthy of note that the two lowest temperatures, viz., 96·4, both occurred during steep ascents and before stopping, and while I was perspiring freely and feeling hot. In each case I immediately sat down and noted a progressive rise in the temperature, though at the same time I was feeling much cooler. When I began to shiver from sitting above half an hour in a strong wind on the top of Whernside the temperature had actually risen to 99°·3. This reminds one of the cold stage of ague, when a patient may have a temperature of 105° while his teeth are chattering with cold.

I entirely agree with Dr. Marcet that it is the fact of actively climbing and not the actual elevation, which influences the temperature. When sitting quiet on the top of Whernside and Gragreth the temperatures were at or above the normal. The steepness also appears to have great influence ; both these mountains have flattish tops, and the temperature on reaching the top of Whernside shows less depression than during the ascent, while that taken walking on the flat top of Gragreth, though without stopping, after the ascent showed scarcely any.

I noticed no depression of temperature in descending, though I often came down at a run, and none in several long level walks.

And now as to any possible fallacies. The same thermometer was used in all the observations. It is a Philips' maximum, by Wood and Co., of York, is graduated in fifths of a degree, and easily reads to tenths. I have compared it with a thermometer certified at Kew, and find it very exact. It rises to within a degree of the truth in ten seconds after putting under the tongue, and I am accustomed to rely on its indications after being in about two minutes. In all the above observations it was left in the same position under the tongue five minutes by the watch (except the reading at 2.33, when it was only four) ; consequently any failure to rise to the true temperature would be likely to affect all the readings nearly alike. Whatever error may be due to this cause would be likely to show itself in raising the readings during the ascents, as at these times the heart was beating strongly and the circulation particularly active ; so that the cooling of the mouth by the cold bulb would be quickly neutralised. I was also particularly careful not to allow any air to enter through the lips and as little as possible through the fauces, and feel confident that there is no appreciable error from this cause.

As to the *rationale* of the process, may not the following theory embrace all the facts as observed by Marcet, Forel, and others?

Heat motion and chemical force are merely varieties of one force convertible under certain conditions. The human body is an engine, in which muscle and other tissues are oxidised, and the resulting chemical force is transformed into an equivalent amount of motion and heat. Now it is manifest that there is a limit to the rate at which oxidation can go on in the body, and consequently to the amount of force available for transformation in an unit of time into motion and heat. Usually the human machine is not worked up to its full power ; the amount of motion produced is nothing approaching what is possible, and only sufficient force is transformed into heat to keep the body at the normal temperature of 98·4 ; but in the limit the two processes become complementary to each other, and if from any cause the force converted in one direction exceeds a certain amount, the excess can only be obtained at the expense of what would ordinarily be converted in the other. Now, in mountain climbing the amount of motion as expressed in foot-pounds of work done is very great, and much exceeds the amount to which most of us are accustomed in walking on a level road. If this be pushed to the limit it encroaches on the amount of force destined for the supply of heat to the body, and the temperature falls. It is clear that these processes habitually go on at different rates in different individuals ; if so, may not the limit of the rate of tissue change be different? One man may be able to push his motion production nearly to the limit up to which his oxidation will work, thereby encroaching on what ought to sustain his temperature, while another, whose muscles are less fully under the dominion of his nerves, or whose power of oxidation is considerable, may be unable to reach that limit.

To this class I believe Dr. Forel to belong ; in the other, the slow oxidisers, I find myself in the honourable company of Drs. Marcet and Lortet. TEMPEST ANDERSON

17, Stonegate, York

Trevandrum Magnetic Observations

THOUGH I have felt much gratified with the notice by Prof. B. Stewart of the first volume of the "Trevandrum Observations" which appeared in last week's NATURE, p. 163, I desire, nevertheless, to make a few remarks on the only point on which we appear to differ.

There are two methods of investigating the laws of magnetic disturbance, which have quite distinct objects ; one, which has been employed with much success by that eminent veteran of science Sir E. Sabine, seeks, as he has expressly stated, the laws of the *larger* disturbances only, and for this end chooses only those deviations from the mean positions that are greater than some arbitrary value. The other method seeks the laws of disturbances of *all* magnitudes, and employs deviations of *all* amounts.

As Prof. Stewart regrets that I have employed the latter method, and suggests that the former may yet be used by others, it may be supposed that the laws of disturbance are not found by me, and are not to be found by the method which I have employed. This would be a great mistake; one which I am bound to correct.

The method which Prof. Stewart recommends has had objections proposed to it by the Astronomer Royal, the Provost of Trinity College, Dublin, and by myself. It is, I think, to defend the method against these objections that Prof. Stewart has written his remarks on the modes of discussion; but I have never heard any objections to the other method, nor, as far as I can understand, does he offer any.

As the method followed by Dr. Lloyd on the Dublin Observations and by myself on the Makerstoun and Trevandrum Observations has shown every law of magnetic disturbance that has been obtained by the other, I am afraid I cannot see that the illustration of the cyclones is applicable to the two methods, even if we were bound to study large cyclones only and to put those of less than a given magnitude out of consideration.

4, Abercorn Place, London, N.W. JOHN ALLAN BROUN

Anomalous Behaviour of Selenium

IT has been lately observed that the electrical resistance of selenium is greater in the light than in the dark. It was at first thought possible that this increase of resistance might be due to heat admitted with the light, but Prof. W. G. Adams, in his paper read before the Royal Society, June 17th, 1875, has shown that this is not the case, but that the phenomenon is a purely optical one.

The writer of this letter has to-day tried an experiment with a selenium bar belonging to the Cavendish Laboratory. Its length is 50 mm., breadth 8 mm., thickness about 1 mm.; platinum wires are soldered to its ends, and it has a hard metallic surface. Its electrical resistance is enormous. In the dark it is just over 100 megohms (100,000,000 B.A.U.) When, however, the light of the paraffin lamp of the galvanometer was allowed to fall on it from the distance of about a foot, the resistance DECREASED between 20 and 30 per cent. The experiment was repeated many times, with current sent sometimes one way, sometimes another, and with different sides and edges of the bar turned to the light, but always with the same result, namely, that the effect of letting in the light was to largely *decrease* the resistance.

A second set of experiments were made with a selenium medal struck by Berzelius soon after the discovery of the metal in 1818, and presented by him to Mr. Deck, by whose son, Mr. Deck of Cambridge, it was kindly lent for the experiment. This medal was of oval shape, about 40 millims. long by 30 broad. Owing to the difference of form between the two specimens, their specific resistances could not be accurately compared; that of the medal was, however, not more than about $\frac{1}{48}$ of that of the bar. The medal was exactly like black lead both to touch and sight, and quite different in appearance to the bar. The resistance of the medal *was sensibly the same, both in the dark and in the light; no difference could be detected.*

These experiments seem to show that the physical form of the metal has a great deal to do with its behaviour when carrying an electric current and exposed to light.

J. E. H. GORDON

Cavendish Laboratory, Cambridge, June 29

The House-fly

AS no one more competent than myself seems disposed to reply to the query of "Harrovian" (NATURE, vol. xii. p. 126) respecting a disease of the house-fly, and which is again referred to by the Rev. D. Edwardes in last week's NATURE, I may perhaps be permitted to make a few remarks thereon.

I have frequently noticed dead and dying flies thus affected, generally in the late summer and autumn; and I think I am right in attributing the phenomenon to the growth of a parasitic fungus, called, I believe, *Empusa musci*, in the fly's body. The insects may often be seen settled in a natural position on window-panes, but with the abdomen much distended, and surrounded by a collection of whitish powder, extending for a few lines in all directions on the surface of the glass. The whole of the interior organs of the abdomen are consumed by the plant, nothing remaining but the chitinous envelope, on which the mycelia of the fungi form a felt-like layer; the fructification showing itself externally as filaments protruding from between the rings of the body.

Insects are very subject to the attacks of such parasites. Some of those living in the interior organs of the body seem to do little if any injury to their "hosts," while others completely destroy them; as in the case of *Sphæria*, which changes the caterpillars at whose expense it lives into a mass of fungoid growth of most grotesque appearance. It is now well ascertained that a species of *Botrytus* produces the dreaded "Muscardine" of the silk-growers; and every practical lepidopterist has had to lament the destruction of pet broods of larvæ by some similar disease, which, though perhaps sometimes pathological, is probably in the first instance set on foot by fungi.

The whole subject of the parasites of insects is extremely interesting. According to my experience it is the exception for an insect to be quite exempt from the attacks of one or more animal or vegetable entozoic or epizoic organism; and I have often found five or six different species inhabiting one unfortunate individual.

I may mention that "Harrovian" will find some remarks on this fly-fungus by Dr. Cohn, in an early volume of the *Journ. Micros. Science*. I regret that, writing away from home, I cannot give the exact reference. W. COLE

Stoke Newington, N., July 2

[We print this letter from among several which all correctly explain the phenomenon under consideration in a similar manner.—ED.]

Theories of Cyclones

IN NATURE, vol. xii. p. 98, you notice a paper by Dr. Hann on two rival theories of cyclones. According to one, "whirlwinds are formed mechanically by different streams of air meeting, and centrifugal force causes the central depression. The more modern theory regards a local depression as the first condition, causing an indraft resulting in a whirlwind through the earth's rotation: the primary depression is held to follow condensation of vapour."

The question is how the cyclone begins: whether the first depression is due to the centrifugal force of an eddy, or to the expansion of air in the upper strata from the heat liberated in the condensation of vapour. There need not be any controversy as to the dynamics of the cyclone after it is formed.

There is a mass of geographical evidence in favour of the first-named theory, namely, that cyclones originate in the conflict of the trade-winds of the northern and southern hemispheres when either trade-wind is drawn to some distance across the equator. (A cyclone cannot be formed on the equator, because there the earth has no rotation in relation to a vertical axis). On this subject see Mr. Meldrum's paper in NATURE, vol. ii. p. 151, and my letter in NATURE, vol. iv. p. 305; also Mr. Maury's paper in NATURE, vol. viii. pp. 124, 147, 164.

Mr. Maury fully recognises the truth that the motive power of the cyclone, once it is formed, consists in the heat liberated by the condensation of vapour, which causes expansion in the upper strata and produces an ascending current. I believe the nature of these actions was first explained by Espy, whose "Philosophy of Storms," though well known by name, seems to be less appreciated than it deserves.

There is, however, another reason for the existence of an ascending current at the centre of a whirlwind, which I do not think I have seen stated. The lowest atmospheric stratum of a whirlwind is retarded in its motion by friction against the earth, and its centrifugal force is thereby lessened in proportion to that of the upper strata. The effect of this relative deficiency of centrifugal force in the lowest stratum—that is to say, at the surface of the earth—must be to cause a flow of air at the surface of the earth towards the centre of the whirlwind, and an ascending current at its centre. Such an ascending current is probably the cause of the vertical columns of dust that accompany those small whirlwinds which are common in windy weather.

Old Forge, Dunmurry, JOSEPH JOHN MURPHY
Co. Antrim, June 23

The Dark Argus Butterfly

IT is stated in H. N. Humphrey's work on "British Butterflies," that the Dark Argus Butterfly appears in July, and has only been found in the neighbourhood of Durham and Newcastle, and seldom above half a mile from the sea. When in May I was at Ashmore, which is on the borders of Dorset and Wilts, I took some butterflies answering exactly to the description of the Dark Argus in Mr. Humphrey's book; so would you kindly inform me whether this is a new locality, and whether there are two broods, the first in May and the second in July, as is the case with several of family, as would appear from the above statements? I identify the species with his Dark Argus by the following peculiarities, viz.: (1) an obscure black spot near centre of fore-wings; (2) *no* black spots in the orange ocelli in fore-wings, the hind-wings containing these black spots as in the Brown Argus.

JOHN HODGKIN, JUN.

West Derby, near Liverpool

Meteorological Phenomenon

WHILE walking out yesterday afternoon my attention was drawn to a very remarkable display of mares-tail clouds spreading from the north, stretching in broad and narrow bands in every direction over the whole sky, and reaching beyond the zenith. While standing thus facing the sun, I saw, at a great elevation, a coloured bow with its convex red side towards the sun; it was only about one-sixth or one-seventh of a circle, and its width seemed to be only about half that of an average ordinary rainbow. It had the appearance of being nearly horizontal, with its centre not far from the zenith, but probably not so distant. Not being accustomed to estimate elevations, when I got home I took a quadrant and held it about the elevation of the part of the bow nearest the sun, and found it came out, on repeated trials, at a *zenith distance* of 25° or 26°.* When I first saw the bow it was just 6h. 30m. P.M. Greenwich time, and the sun appeared to be about 15° above the horizon (that you can correct by calculation). The sun was shining brightly, and the bow was projected over a patch of sky slightly dimmed, at a great height (but below the cirri?), by a smoke-grey haze; its ends just projected over the edges of the clouds. It lasted about 2m. and then faded away. There was no halo or ring but this. The wind was a rather fresh breeze, between S.S.E. and S.

Norwich, June 28 HENRY NORTON

OUR ASTRONOMICAL COLUMN

SÛFI'S DESCRIPTION OF THE FIXED STARS.—The author of the ancient Uranometria to which we adverted last week, Abd-al-Rahman al-Sûfi (an abbreviation of a much longer name), was born in 903; he was of the sect of the Sûfis, and of Rai, a place to the east of Teheran. He was in high favour with Adhad al-Davlat, of the reigning family of Persia, and it was principally for the instruction of this prince that he wrote the work under notice, which was not the only one he produced. Ibn Jounis reports that he was not only an observer, but framed astronomical tables; and Dr. Schjellerup states he is known to have undertaken geodetic operations. He is said to have determined the length of the year, and in his tables fixes the mean motion of the sun in the Persian year at 359° 45′ 40″·2. He died in May 986. The prince Adhad al-Davlat, who gave great encouragement to the study of the sciences, commenced his reign in 949, and at the time of his death, in 983, governed the extent of country situate between the Caspian and the Persian Gulf.

The translation of the "Description of the Fixed Stars" by Sûfi was made by Dr. Schjellerup from a manuscript preserved in the Royal Library at Copenhagen, which came into the possession of Niebuhr in 1763. It is a copy made in 1601 from a manuscript transcribed in 1013, and, as stated by Schjellerup, "directement d'après l'exemplaire de Sûfi." The translation was finished when the Danish astronomer, through Herr Dorn, had the opportunity of consulting another copy of Sûfi's work, recently acquired by the Imperial Library of St. Petersburg. Where differences exist between the two authorities, they are particularised in notes to Schjellerup's translation.

The description of the stars by Sûfi, though founded upon that of Ptolemy, is not merely a simple translation. All the stars contained in Ptolemy's catalogue were sought in the positions there recorded, and submitted to attentive examination, and their magnitudes carefully noted, as is distinctly stated by Sûfi in his preface. Schjellerup draws attention to the great extent of his work, the perseverance displayed, and the minute accuracy and scientific criticism with which the whole is executed; so that, under all circumstances, the Persian astronomer has presented us with the state of the sidereal heavens in his time, which merits the highest confidence, and which during nine centuries remains without a rival, not having found its equal till the appearance of the "Uranometria Nova" of Argelander.

Prefixed to the description of the constellations, Schjellerup has published what he terms "Tableau synoptique de l'intensité lumineuse des étoiles principales selon Ptolémée (ou Hipparch), Sûfi et Argelander," which is obviously a valuable compilation, and one that may be frequently consulted in cases where the naked-eye stars are suspected of variability. The magnitudes attributed to Ptolemy are not those given in our editions of the "Almagest," but are taken from the work of Sûfi; indeed, Schjellerup considers the former "parfaitement inutiles," being expressed in round numbers and with much confusion, so that in this respect also we have an important addition to our knowledge of the magnitudes of the stars.

In Sûfi's tables of positions, the longitudes of the Almagest are increased 12° 42′, the latitudes being unaltered.

Generally speaking, there is a fair agreement between the magnitudes of Ptolemy and Argelander, the differences not often exceeding a degree of the scale. Amongst the larger discordances Schjellerup points to the cases of 25 Orionis and ρ Eridani, estimated by Ptolemy of the third and fourth magnitudes respectively, while by Argelander they are called a bright fifth and a sixth. Sûfi's estimates in the middle of the tenth century are intermediate, the first star being rated a fourth and the second a fifth magnitude. The case of Sirius is worthy of attention for another reason. Cicero, Horace, and other classical writers refer to the ruddy colour of this star. In the editions of Ptolemy it is indicated as *ὑπόκιῤῥος*, but Sûfi makes no mention of this reddish tinge, though, as was stated last week, other stars well marked as red stars in our own day, are also so distinguished in his description of the heavens. Instead of reading with Halma *καὶ ὑπόκιῤῥος*, Schjellerup thinks we should more correctly read *καὶ σείριος*, conformable to the designations which Ptolemy gives to the other bright stars which bear a proper name, as with α Bootis (*ἀρκτοῦρος*), α Leonis (*βασιλίσκος*), &c.; and remarks that it is certain Cicero was the first who mentions the ruddiness of Sirius, that Horace followed him, and that after Seneca we find no reference to it. Eratosthenes, Aratus, Manilius, Hyginus, and Germanicus are silent as to this particularity of the star.

The great nebula in Andromeda is named by Sûfi as an object generally known in the heavens, and it is interesting to note that he also records the variable star recently detected by Herr Julius Schmidt near α Virginis. Its position is very clearly described.

The title of Schjellerup's translation is "Description des Étoiles Fixes, composée au milieu du dixième siècle de notre ère, par l'Astronome Persan Abd-al-Rahman al-Sûfi, par H. C. F. C. Schjellerup, St. Petersbourg, 1874." It was presented to the Imperial Academy in June 1870.

SOLAR RADIATION AND SUN-SPOTS

SINCE I communicated to NATURE the first results (vol. xii. p. 147) of an examination of the Indian registers of solar-radiation temperatures, I have examined some other registers, all of which confirm the conclusion adumbrated in my former note. Among these the most interesting and striking is the hill station Darjiling, in Sikkim, nearly 7,000 feet above the sea. The place is very cloudy, being on the outer Himalayan range, and much exposed to the moist southerly winds, but it has two advantages over the stations in the plains, viz., that there are nearly 7,000 feet less atmosphere above it, and it is free from the dust haze, so prevalent on the plains, which perhaps more than water vapour (if not thickly condensed) stops a large part of the solar radiation. On clear days and in intervals between the clouds, the sun's heat is sometimes very intense. The table that follows has been compiled in a different manner from that which I communicated a fortnight since. Instead of picking out days with little or no cloud (which are sure enough during the greater part of the year), I have taken the three highest recorded sun-temperatures in each half-month, and from these have deducted the maximum air-temperatures recorded on the same days; the mean of the six observations being taken to represent the month. The same instrument has been in use since the observations were commenced in April 1870. I must leave it to meteorologists at home to compare these temperatures with the recorded sun-spot areas, which I am unable to ascertain. But the maximum radiation temperature evidently falls in 1871, the year of maximum spots, and the increase on that of the imperfect year 1870, and the fall in the subsequent years, at least up to the end of 1874, are very marked.

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* Subtended at my eye by bow and sun = about 50°?

Mean differences of the three highest solar temperatures in each half-month and the corresponding maximum air temperatures at Darjiling.

	1870.	1871.	1872.	1873.	1874.	1875.
January	—	57·8	67·7	59·2	57·8	62·3
February	—	62·2	62·8	62·3	56·5	60·3
March	—	63·3	63·5	62	58·2	57·8
April	-	64·2	63·2	62·8	55·7	60·2
May	62·2	67·8	66·8	63·8	57·8	—
June	67	68	67·3	62·5	59·2	—
July	63·3	66·2	65·7	60·8	56·3	—
August	70·8	65·7	66·8	60	57·8	—
September	71·5	69·3	63·7	62·3	59·3	—
October	65·5	68·2	70	63·3	60·8	—
November	62·5	67·3	62·5	57·3	63·3	—
December	59	66·3	59	53·8	60·5	—
Yearly means	—	65·5	64·9	60·8	58·6	—

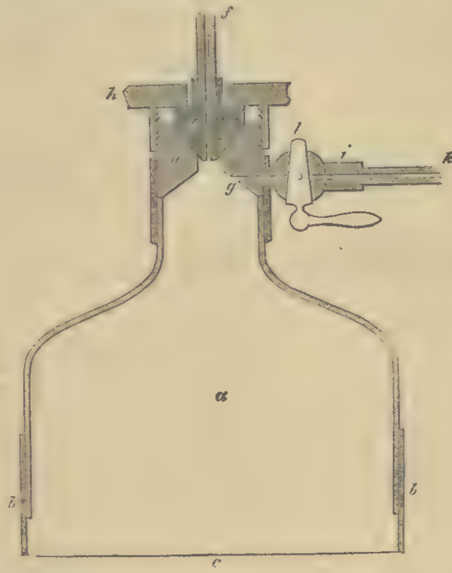
In my former note I adverted to Prof. Köppen's results on the variation of the temperature of the lower atmosphere in the tropics, which he showed to be inversely as the number of the sun-spots or nearly so, from 1820 to 1858. On thinking the matter over, this result, however anomalous at first sight, appears to me really only in conformity with what might be expected when taken in connection with the facts of the rainfall. Since three-fourths of the earth's surface are covered with water, the chief effect of increased radiation must necessarily be to increase the evaporation, and therefore the cloud and rainfall. The former of these will intercept a larger proportion of the solar heat and prevent its reaching the ground; while the latter, by its evaporation from the land surface, will still further reduce the temperature. The annual curves of temperature at the Bengal stations show most strikingly how the temperature falls with cloud and rain. A single heavy storm without any change in the prevalent wind direction reduces the temperature by several degrees for two or three days after the fall; and the same fact is illustrated in the mean annual curve, which falls considerably on the setting in of the rains, while there is generally a slight rise in September when the rains draw to a close. It follows, then, that the whole increase of the sun's heat and something more, in the tropics, is absorbed in evaporation and by the upper strata of the atmosphere, thus affording a confirmation of the speculation of (I think) Sir John Herschel, that the inferior planets (if partly covered by water) may enjoy an equable moderate temperature fitted for the existence of such terrestrial organisms as can thrive under a sombre sky.

June 7 H. F. BLANFORD

SCIENCE IN GERMANY

(*From a German Correspondent.*)

BUNSEN'S ice-calorimeter was used lately for a very interesting experiment by Messrs. Röntgen and Exner, who tried to determine the intensity of the radiation of the sun by means of an apparatus constructed on the principle of that calorimeter. The apparatus consists of a glass bell *a* of 75 mm. height. This is fastened into a brass hoop *b*, which is closed below by a plate of wrought silver of ¼ mm. thickness, and 106 mm. diameter. The neck of the bell bears a massive brass top *d*, which is cut conically above and below, and has a central opening of 6 mm. diameter. Into the exterior groove a massive brass cone *e* fits water-tight, having also the central boring, into which a little glass tube is fastened. By a screw *h* in the circumference, the cone *e* can be firmly pressed against the brass piece *d*, while the tube *f* communicates with the interior of the bell *a*. A second communication between the interior of the bell and the outside is obtained by the boring at *g* and the metal-tube *i*, with stopcock *l*.



When the apparatus is to be used as a pyrheliometer, the bell is filled with well-boiled distilled water, and the whole is frozen like one of Bunsen's calorimeters. To the tube *f* a long glass tube of perfect calibre and with millimetre divisions is fastened by means of a piece of india-rubber tubing; to the end *k* of the brass tube with stopcock an indiarubber ball filled with well-boiled water is then fastened, the stopcock opened, and while the apparatus is held vertically, all air which may still be contained in the bell is removed from it through the cone *e*, the tube *f*, and the divided tube, so that the latter is filled with water up to its end. Then the stopcock *l* is closed. If beforehand the silver plate has been carefully covered with soot, the apparatus is ready for use. It is directed towards the sun just like Pouillet's pyrheliometer, so that the sun's rays fall vertically upon the blackened plate. The divided tube is then supported as much as possible in a horizontal position, and the progress of the column of water in the same is observed with a second clock from minute to minute. This progress of the column of water would indicate directly the intensity of the radiation of the sun in calories if the ice did not also partly melt in consequence of the surrounding warm air. In order to eliminate this influence, the progress of the column of water must be observed before and after the actual experiment, and during these observations the sun's rays must be shut out from the apparatus by a screen. The difference of the readings with and without the sun's rays will then indicate the density of the latter. But this method has a drawback. It was found that with experiments which were made in quick succession, when the apparatus was exposed to the sun's rays, that the first results were always a little larger than the following ones, and that only after some time had elapsed did the results show a constant value. The reason of this is doubtless the formation of a stagnant layer of water in the apparatus below the blackened plate, and this layer must first reach a stationary position before anything like regularity is obtained in the results.

With regard to the general results of these experiments, which were made by Messrs. Röntgen and Exner on the platform of Strassburg Cathedral, the absolute values of the intensity of the radiation of the sun are considerably larger than those found by Pouillet. If Pouillet's values are reduced to the same measures and units, which form the basis of the values obtained by Röntgen and Exner, we find, for instance, for the month of June and the sun's elevation 12h. the value 1·140, while the latter observers still obtained 1·226 for an elevation of 12h. 15m. Further, we must remark that the values obtained by Röntgen and Exner are decidedly too small (the observations record the progress of the column of water after the stationary condition of the stagnant layer of water), and that according to a rough guess they should be at least 20 per cent. to 25 per cent. larger; thus it is certain that Pouillet's values must be looked upon as *considerably too small.*

*FERTILISATION OF FLOWERS BY INSECTS**

XI.

Adaptation of Flowers to Lepidoptera—Hesperis tristis.

LEPIDOPTERA are distinguished among all insects that visit flowers by their slender proboscis. Hence, in order to make their honey exclusively accessible to these insects, flowers have only to narrow the entrance to their nectaries to such a degree that no other proboscis but that of Lepidopterous insects is able to enter. This adaptation to butterflies by narrowing the entrance of the nectary in different families of plants has been arrived at in very different ways. In flowers with a tubular corolla (*Primula villosa*, *Daphne striata*, NATURE, vol. xi. p. 110, Figs. 43-47) the corolla-tube has narrowed; in flowers with a honey-secreting spur (*Gymnadenia*, *Nigritella*, NATURE, vol. xi. p. 170, Figs. 58-62) the entrance of the spur has been constricted; in the labiate flowers of *Rhinanthus alpinus* (NATURE, vol. xi. p. 111, Figs. 51-56) the large entrance of the flower is blocked up by the margins of the upper lip lying close together, and only a small opening in its rostrate projection has been left open; in the quite open flowers of *Lilium Martagon* (NATURE, vol. xii. p. 50) the honey-secreting furrow at the base of the sepals and petals has been converted into a narrow channel by a coating of glandular hairs. *Hesperis tristis*, belonging to the family of Cruciferæ, which are generally visited for honey by Apidæ, Syrphidæ, Muscidæ, and various other insects, has excluded from its honey all visitors except Lepidoptera, by simply lengthening its sepals and the basal portion of its petals and laying them close together. The sepals, indeed, as is shown by Fig. 65, are elongated to 11-15 mm., and whilst diverging and presenting open slits in their basal portion, are convergent and connate towards their tips. By this coalescence of the sepals the entrance of the flower is so constricted as to be almost completely filled up by the four longer anthers (*a*, Figs. 68, 69). At first, when the

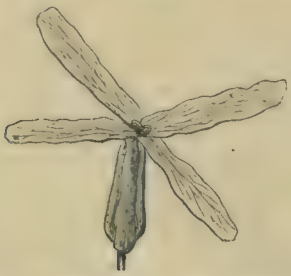


FIG. 65.—Flower of *Hesperis tristis* (natural size).

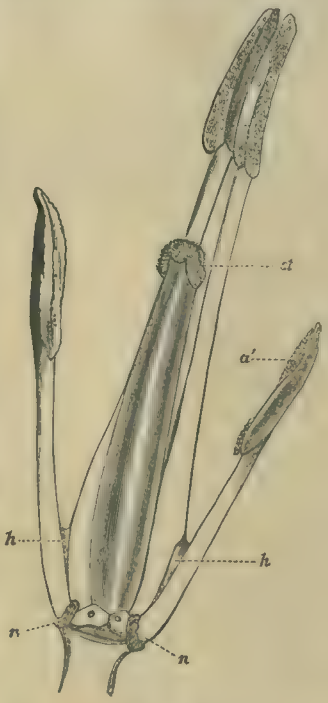


FIG. 66.

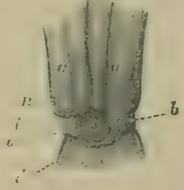


FIG. 67.

FIG. 66.—The same after the sepals, the petals, and two of the four longer anthers have been removed. *n*, nectary; *h*, honey; *a'*, shorter anther; *st*, stigma.

FIG. 67.—Situation of the nectary. *a a*, longer filaments; *o*, point of insertion of one of the shorter filaments; *b b*, points of insertion of the two adjacent petals; *d*, insertion of the adjacent sepal; *n*, nectary.

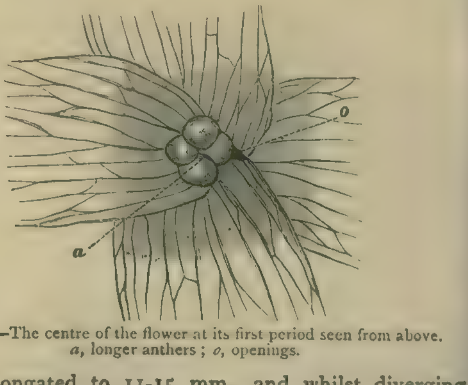


FIG. 68.—The centre of the flower at its first period seen from above. *a*, longer anthers; *o*, openings.

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* Continued from p. 50.

flower has just opened, only a single very small opening is commonly left free (*o*, Fig. 68); somewhat later, when the longer anthers have advanced a little further, two small openings are frequently obvious (*o o*, Fig. 69), by which Lepidoptera can insert their proboscis. The exclusion, however, of all other insects from the honey would be useless or even fatal to this, as well as to the above mentioned flowers, unless by particular contrivances, (1) increased frequency of the visits of Lepidoptera, and (2) certain cross-fertilisation by them were effected. *Hesperis tristis*, by the very inconspicuous colour of its flowers, which are yellow reticulated with purplish streaks, by opening them in the afternoon, and by having no smell in the daytime whilst very fragrant towards the evening, proves to be adapted exclusively to crepuscular and nocturnal Lepidoptera, which, attracted from afar by the sweet odour, are induced to pay frequent visits. The base of each of the two shorter filaments is surrounded by a greenish swelling (*n*, Figs. 66, 67), which secretes on its inside honey so copiously that it rises in the interstice between the shorter and the two adjacent longer filaments. Cross-fertilisation by the visits of moths is secured in the following manner. From the one or two small openings (*o*, Figs. 68, 69) the proboscis of the moth is guided downwards by the longer filaments as in a channel, first along one side of the stigma (*st*, Fig. 66), which has bent downwards on both sides just into the way of the proboscis, then along the shorter anther (*a'*, Fig. 66), which from the other side has turned its pollen-covered front likewise exactly into the way of the proboscis, until at last it reaches the honey (*h*, Fig. 66); the proboscis afterwards wetted with honey at its tip, when retracted, first touches again the anther *a'* with one side, which is thus charged with pollen, then with the other side the stigma, which thus escapes fertilisation with its own pollen, and when in the next visited flower the tip of the proboscis with its pollen-charged side touches the stigma, cross-fertilisation is effected.

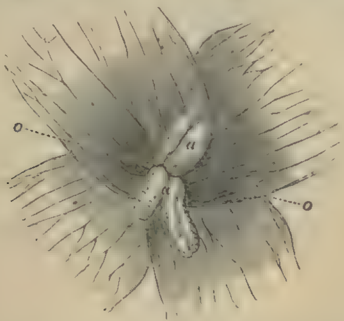

FIG. 69.—The same, at a somewhat later period.

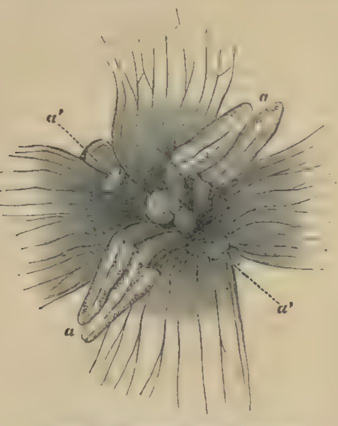

FIG. 70.—The same in its last state.
(Figs. 66–70 are seven times magnified.)

My daughter Agnes, perseveringly watching *Hesperis tristis* during several mild evenings in the month of May, has succeeded in observing and catching the following fertilisers of it:—(1) *Plusia gamma*, frequently (length of the proboscis 16-18 mm.); (2) *Hadena sp.* (11 mm.); (3) *Dianthœcia conspersa*, W.V., twice (13 mm.); (4) *Iodis lactearia*, L.; (5) *Botys forficalis*, L., three times.

But although in calm and warm evenings, as is proved by these observations, cross-fertilisation may be sufficiently effected; yet in unfavourable weather all flowers of many individuals develop and fade without experiencing any visit of fertilisers. In this case, nevertheless, almost every ovary develops and brings to maturity its seed-vessels, self-fertilisation being regularly effected by the pistil growing and the stigma coming into contact with pollen-grains of the four longer anthers.

Thus, in these flowers the four longer anthers have apparently no other function in the first period of flowering but to exclude incompetent visitors from the honey, by stopping the entrance of the flower, and, by the direction of their filaments, to keep the proboscis of the fertilisers in the right direction, whilst in a later period, in case visits of moths have been wanting, they regularly effect self-fertilisation. The two shorter anthers, on the contrary, are exclusively adapted to cross-fertilisation by visiting moths.

Lippstadt HERMANN MÜLLER

JOSEPH WINLOCK

THE following details concerning the late Prof. Winlock, whose death we announced last week, we take from the New York *Nation*:—

Prof. Joseph Winlock, Director of the Observatory of Harvard College, died suddenly after a brief illness last Friday morning, June 11, at the age of forty-nine. One of the foremost of American astronomers, whose honourable career in science began thirty years ago, who has filled with great credit several important positions of scientific labour and trust, is thus cut off in the midst of a life whose usefulness cannot be estimated by ordinary standards. Well known and highly estimated by all active collaborators in astronomy both at home and abroad, he was never so well known to others or to the public as his important services deserved. This was chiefly on account of a modest shrinking from any candidacy for honours, amounting almost to an aversion from them, and an indifference to an uncritical or merely popular reputation. Immediately upon graduating from Shelby College, Kentucky, in 1845, he was appointed Professor of Mathematics and Astronomy in that College, where he remained until 1852, when he removed to Cambridge, Mass., and took part in the computations of the *American Ephemeris and Nautical Almanac*, then under the superintendence of Admiral C. H. Davis. In 1857 he was appointed Professor of Mathematics of the United States Navy, and in that capacity served in succession as Assistant at the Naval Observatory at Washington, as Superintendent of the *Nautical Almanac*, and as Director of the Mathematical Department of the Naval Academy at Annapolis, Md. On the breaking out of the war, in 1861, he was a second time made Superintendent of the *Nautical Almanac*. His next service to astronomy was in the position of Director of the Observatory at Harvard College, and Phillips Professor of Astronomy, to which he was appointed in 1865—a position already made highly honourable by the labours of his predecessors, the distinguished astronomers, Professors W. C. Bond and G. P. Bond. He has also served at the same time as Professor of Geodesy in the Mining School of Harvard College. Only a few months ago, Mr. Bristow appointed him the chairman of the Congressional Commission for

Investigating the Causes of Steam-Boiler Explosions. These many appointments to places of responsibility are evidences of the rare sagacity, skill, sound judgment, and integrity of character which were qualities conspicuous to all who knew him well or dealt with him in his various duties. Upon taking charge of the Cambridge Observatory, he proceeded with energy to complete its equipment, adding to its already famous resources a meridian circle, constructed in accordance with his designs by Throughton and Simms of London—an instrument whose performance has been pronounced by competent judges the best of its kind in the world. The distinguished astronomer, Adams, of Cambridge, England, subsequently ordered an instrument from the same makers to be constructed on the same model. Prof. Winlock also secured for this Observatory a very perfect astronomical clock, made by Frodsham of London, from which, through contrivances of his own, true time is telegraphed to neighbouring cities. He also set the famous equatorial instrument of the Observatory upon a new career of usefulness and glory in astronomical spectroscopy. In 1870 he put into regular working efficiency a mode of observing the sun—namely, by a single lens, a heliostat, and photograph—which he independently conceived, and was the first to utilise as a form of systematic observatory work. French astronomers have lately been contending with one another about priority in the conception of this method of observation, which was so important a part of the equipment for observing the transit of Venus last December furnished to American expeditions; but in all that really constitutes effective originality, the honour of this invention undoubtedly belongs to Prof. Winlock. He was, however, almost entirely indifferent, in the singleness of his devotion to his favourite science, to popular fame, or even to contemporary recognition. Besides his observatory work, he was engaged on two occasions in the direction of expeditions to observe solar eclipses—namely, that to Kentucky in August 1869, and that to Spain in December 1870. Though ingenious as an inventor, his judiciousness was so much more prominent a quality that his originality is shown rather in a thoroughness and detailed efficiency of contrivance than in the more brilliant qualities that distinguish the more famous inventors. Very numerous little but very effective improvements in astronomical methods distinguish the astronomical art of the present day; and in these Prof. Winlock's originality was considerable. Among his published works, besides the "Annals of the Observatory" under his directorship, are a set of tables of the planet Mercury (arranged with characteristic neatness and ingenuity); brief papers in astronomical journals and in the *Proceedings of the American Academy of Arts and Sciences*. He was a native of Kentucky, and the grandson of General Joseph Winlock, who entered the American army at the beginning of the Revolutionary War, and also served in the war of 1812, and was a member of the convention which drew up the constitution of the State of Kentucky.

INDIA MUSEUM, SOUTH KENSINGTON

THE India Museum, which was opened in South Kensington last month, was founded by the Court of Directors of the Honourable East India Company in 1798. In 1860 it was removed from Leadenhall Street to Fyfe House, and in 1869 to the India Office. The galleries of the Exhibition Building, in which it is now temporarily lodged, have been leased from H.M. Commissioners for the Exhibition of 1851 for three years. The lower gallery is devoted to Raw Products, and the upper gallery to Manufactures. The present arrangement of the India Museum Collections is to a large extent only temporary, and fulfils mainly the purpose of bringing them into view preparatory to their final classification. The preparation of Descriptive Catalogues will go hand in hand with the completion of the different groups.

A handy little penny Guide has in the meantime been officially issued, which will be found of considerable service in enabling the visitor to make a systematic inspection of the large collections which have been for so long stowed away in various cellars and ware-rooms in the topmost story of the New India Office. Now that this Museum has been brought "to the light of common day," and that the public has a chance of estimating the value of its treasures, we are sure that when the lease of the Exhibition rooms expires, permanent accommodation will be allotted to it, we hope in connection with an India Institute so ably advocated by the Director of the Museum, Dr. Forbes Watson. On four days of the week the charge for admission is only one penny, and sixpence on the other two days. We purpose at present to give some account of the Botanical and Zoological Collections in the Museum.

Room No. 1 is devoted to the commercial products of the vegetable kingdom, with the mechanical appliances associated with their cultivation, collection, or preparation, and is under the superintendence of Dr. M. C. Cooke. A complete collection of these products is exhibited in small tin cases with glass fronts, which are arranged in metal frames, and suffice to give a general view of the productions of the country. Supplemental to this the principal trade articles receive special illustration in a more extended manner in central cases. As this is a new feature in the arrangement of this section, it will take some time before it can be fully and properly developed. What has been done with cotton will in part illustrate what is intended with other products. In this instance the cotton is shown from all parts of India, at first in the boll, then in the seed; afterwards cleaned, together with the seed and oil therefrom, with the waste obtained in the processes of cleaning and spinning and its economic applications. The processes of spinning are next illustrated, with the resultant twists and yarns. These are succeeded by grey and bleached cloth, printing blocks, samples of dyed and printed fabrics, and coloured yarns. Underneath these cases are arranged the agricultural implements employed in the cultivation of cotton, churkas and rollers for cleaning it from the seed, models of spinning wheels and other appliances illustrating the manipulation of the cotton fibre. Above the cases are displayed drawings of the varieties of cotton plants, and of the natives at work at the different processes through which the cotton passes from the ploughing of the soil to the complete woven fabric. By this mode the whole history of the progress of cotton from first to last is exhibited at one view, or at least as much of it as could be compressed within available space. Hitherto, although agriculture, and especially its food products, has been fully illustrated, forestry has not had by any means the share which its importance demands. It is contemplated therefore to expand this new division considerably by the addition of collections of the timbers of the three presidencies and of native states, each by itself, so as to show the character of the forests in each division, accompanied by maps and drawings or photographs of the trees. The products of the forests, other than timber, will be shown collectively for the whole of India, accompanied by such diagrams, drawings, and statistical tables as may be necessary; and the fungoid pests and enemies of arboriculture will also be illustrated. Already this illustrative mode of exhibition has commenced, but will evidently proceed slowly, as diagrams, drawings, and tables will have to be constructed, and probably some of the illustrations must be obtained direct from India.

It may be remarked that Cinchona Bark from the Neilgherry plantations, as well as from Kangra, has the honour of a case to itself, and it is hoped that soon another important drug recently introduced—Ipecacuanha

—will be represented by samples grown in India. The economic plants introduced into India must necessarily form an important feature in its trade museum. Amongst trees *Eucalypti*, the baobab, cork oak, mahogany, have not as yet produced marketable results; but tea, cinchona, senna, nutmegs, pepper, cinnamon, cloves, barley, tapioca, the Maranta arrowroot, Orleans and Egyptian cotton, with their hybrids, Carolina rice, &c., are a few of the instances in which the successfully introduced plants have added, or promise to add, considerably to the exports of India. In the development of the natural resources of so vast a region undoubtedly much remains to be accomplished. Passing through this room, a great number of such unknown, undeveloped, or unappreciated objects will not fail to impress themselves upon the attentive observer. Surely with such vast forests, and a system of conservation so steadily pursued, more ornamental and furniture woods are destined to be exported than yet find their way to the coast; and there are at least sound timbers little inferior to teak, such as *Hopea odorata* is said to be, which require only to be more widely known to be more generally appreciated. In resinous products the European markets are as yet but little indebted to the forests of India, but the copals here shown from *Hopea odorata* and *Hopea micrantha* give considerable promise. The wood oils produced by several species of *Dipterocarpus*, and the Burmese lacquer derived from *Melanorrhœa usitatissima*, might be obtained in large quantities, and yet hitherto no practical application for them in this country has been discovered. The latter is employed to a very great extent in Burmah for lacquering furniture and small wares, but it is unsuited for the English process.

Amongst the objects in this room of interest to the botanist rather than to the general public may be cited the Tabashir, a siliceous secretion from the joints of the bamboo; the curious horn-shaped galls called Kakrasinghee, produced on a species of *Rhus*; manna obtained from *Tamarix indica* in the North-west Provinces, and a kind of manna named Shirkhist from the Punjâb, attributed to the *Fraxinus floribunda*; the resin somewhat resembling Elemi, derived from *Boswellia Frereana*, which the late Daniel Hanbury considered one of the ancient kinds of Elemi, but which is disputed on good grounds by Dr. Birdwood; narcotic Indian hemp in different forms, including the Churrus or hemp resin, and various confections into which it enters; the clearing nuts which are employed by natives in clearing water, and are the seeds of a species of *Strychnos*. To which may be added the paper-like bark of *Betula bhojpatra*, used in Northern India as a wrapper for cigars; the bark of one of the species of *Daphne*, from which the renowned Nepal paper is made, and the singular natural sacks made of the bark of *Antiaris saccidora*.

The models of native implements associated with the respective "products," drawings and photographs of the mode of using them, the copious illustrations of plants from whence useful substances are derived, and especially the series of photographs of forest trees, are calculated to increase the public interest in this collection, and add to its usefulness, although these features are not yet developed to the extent or in the systematic manner which they are intended to assume.

Rooms Nos. 4 and 5 contain the zoological collections, under the superintendence of the assistant curator, Mr. F. Moore. In it are comprised the various collections of Mammals, Birds, Insects, &c., contributed by officers of the old East India Company, whose names have been distinguished by their labours in this branch of natural history, of whom may be mentioned Buchanan, Cautley, Finlayson, Hodgson, Horsfield, M'Clelland, Raffles, Roxburgh, Russell, Wallich, &c.

Commencing with the Mammals, in Room No. 5, the various tribes have been so arranged in the several cases that the visitor at a glance may see the principal species in each group. From want of space, however, many of the larger species are at present precluded from being exhibited, and it is proposed to substitute photographs and other illustrations of them.

Following in order come the Birds, which have also been arranged in a similar manner, each group or tribe being represented by prominent and characteristic species.

In this room are also deposited the cabinets of Insects, several groups of which are provisionally exhibited in the window recesses, as well as an unique collection of Indian forest insect pests.

The tribes of Reptiles and Fish are shown in Room No. 4, and, though at present but few species are represented, this section will shortly be enriched by the extensive and valuable collections formed by the Inspector-General of Indian Fisheries.

Supplemental to these groups, which are arranged in a scientific series, these rooms contain an important collection of economic animal products, including an unique series of the silk-producing insects, lac, honey-yielders, and gall-making insects of India, and their several valuable products, as well as groups of pearl-oysters, chanks, wools, plumes, horns, ivory, &c.

For a series of fossils and plaster casts from the Cautley and Falconer collections, as well as the collections of shells and Crustacea, no cases have as yet been erected for their reception.

THE BIRDS OF GREECE *

THE third part of Mommsen's Griechische Jahreszeiten is devoted to an article upon the birds of the classical land, to our better knowledge of which Herr Mommsen's work is intended to contribute—an article which will be quite as interesting to naturalists as to the scholars for whom the periodical in question is primarily designed. The memoir is based upon the notes and observations made during his long residence in Greece and the adjoining parts of the Levant by Dr. Krüper, a naturalist well known to all students of European ornithology for his accurate and painstaking investigations of the birds of those countries, and especially for his discoveries of the breeding haunts of some of the rarer species. Dr. Krüper's notes have been further augmented in value by the co-operation of Dr. Hartlaub, of Bremen, one of the first of living ornithologists, who has contributed the references to the previous authorities upon each species, and a list of the existing memoirs relating to the same subject, besides adding many extracts from former writers to Dr. Krüper's observations.

The total number of species of birds noticed by Dr. Krüper in the present memoir is 358, on each of which notes of a more or less extended character are given. The arrangement adopted for the sake of convenience is that of Lindermayer's "Vögel Griechenlandes," published at Passau in 1860, and hitherto generally recognised as the best authority upon Grecian ornithology. Dr. Krüper's memoir must now, however, be referred to as more complete, and contains many recent additions to Lindermayer's list. We observe, however, that the work extends into limits which cannot (at any rate at present) be called Greece in its modern sense, as Dr. Krüper's recent discoveries in the neighbourhood of Smyrna of such birds as *Picus syriacus*, *Sitta krueperi*, and *Cossypha gutturalis* are introduced into it. It is, however, a matter of great convenience to ornithologists to have Dr. Krüper's notes upon the Birds of Greece and the Levant, many of which have been scattered through the pages of half a dozen periodicals, reduced into order under such excellent superintendence. Dr. Hartlaub's numerous references render the volume of still greater value, and make it one that no naturalist who is interested in the Birds of Europe should omit to consult.

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* Griechische Jahreszeiten; unter Mitwerkung Sachkundiger, herausgegeben von August Mommsen. Heft iii. Schleswig, 1875.

NOTES

On July 5 the Sub-Wealden boring had reached the depth of 1,400 feet, and it is expected that this week it will have reached 1,500 feet. But this will have quite exhausted the funds of the Committee, and Mr. Henry Willett appeals for more subscriptions. "It cannot be too widely known," he states, "that unless 2,000 feet be reached, the solution of the problem is as far off as ever. We have met with nothing to show that Palæozoic rocks, as anticipated, may not lie at the estimated depth." We are inclined to think that Mr. Willett is too desponding in thinking that failure "seems to be imminent" from want of funds. We are sure there are many wealthy men, who, if the importance of the undertaking were properly represented to them, would come to the rescue and advance the trifling sum necessary for the completion of the experiment.

On Saturday last, Sir George B. Airy, the Astronomer Royal, was entertained at the Mansion House on the occasion of the freedom of the City having been voted to him. A considerable number of well-known scientific and other gentlemen were present.

The Royal Commission on Vivisection held their first regular meeting on Monday. The offices of the Commission are at 13, Delahay Street, Westminster.

In connection with the recent volcanic eruptions in Iceland, which have caused great loss and much suffering to the inhabitants, the *Times* publishes the following abstract of a report by the Very Rev. Dean Sigurd Gunnarsson, dated Hallormsstad, in Múlasýsla, April 24, 1875:—"On Easter Monday, early in the morning, loud rumbling noises were heard to the westward, and apparently travelled towards the north-east, in the direction of the mountain ranges bounding the valley of Fljótsdalshérad to the north. Presently the sounds turned backward along the southern mountains as well. The air was heavy and jet black towards the north and north-east. About nine o'clock whitish-grey scoriaceous sand began to fall from the sky, the particles averaging the size of a grain, but in shape longer. The dark column moved on nearer and nearer, and the darkness rapidly increased, while the scoriaceous hail thickened at the same rate. A full hour before noon candles had to be lighted in the houses, and at noon the darkness was as dense as that of a windowless house; even abroad the fingers of the hand could not be distinguished at the distance of a few inches from the eye. This pitch darkness lasted for about an hour. During the dark all glass windows appeared like mirrors to those inside, reflecting the objects on which the light fell as if they had been covered outside with a coat of quicksilver. For four consecutive hours it was necessary to have lighted candles in the houses. During all that time the ashes and the sand were falling thick and fast. Lightning and claps of thunder were at the same time seen and heard in rapid succession, and the earth and everything seemed to tremble again. The air was charged with electricity to such an extent that pinnacles, and staff-pikes of iron when turned into the air, and even one's hands when held up, seemed all ablaze. But the thunder differed from ordinary claps in this, that it travelled in rapidly-repeated echoes across the skies. When the darkness wore off the fall of the ashes abated. The dark column now moved inland towards the upper valleys; but, being there met by a counter current of air, it remained at first stationary for a while, and afterwards moved slowly down country again along the valleys, so that once more the daylight was changed into dusk, which was accompanied by the fall of fine ashes. After the fall the earth was covered with a layer of ashes and scoriæ from 1½ inches to 8 inches deep; coarsest where it lay thickest, in many cases exhibiting pumice boulders twice as large as the fist. In these places the ashes fell hot as embers on the ground. At first the fall of the ashes was accompanied by a foul sulphurous stink, which, however, very soon vanished. When the ashes had any perceptible taste it was that of salt and iron. For three days after the fall still weather prevailed, and the ashes lay undisturbed on the earth. Before the fall of the ashes the land was snowless and pasture plentiful; but after it not a creature could be let out of doors, and the sheep, if they were let out, would run as if mad in all directions. On the fourth day a pretty stiff south-west gale blew the ashes away from the hillocks and mounds, except the finest part, which remained on the sward, presenting the appearance of a compact scurf. But what little good this gale might have done was undone the next day by a wind blowing from north-west."

The *New York Tribune* publishes additional information respecting the disastrous earthquake in South America. The locality where the earthquake occurred is the great coffee district of South America. The region affected by the shocks covers five degrees of latitude, and is 500 miles wide. The shock extended in a north-east direction along the northern range of the Andes. It was felt first very perceptibly at Bogota, the capital of New Granada, thence seemed to travel north, gathering intensity as it advanced, until it reached the south-east boundary line of Magdalena, where the work of destruction began, continuing as it advanced along the eastern boundary of Magdalena, following the line of the mountain range, and destroying in part or whole the cities of Cucuta, San Antonio, El Bosario, Salazar, San Cristobal, San Cayetano, and Santiago. The first premonition of the terrible visitation occurred on the night of May 17, when a strange rumbling sound was heard beneath the ground, although no earthquake occurred. It travelled in the direction afterwards taken by the earthquake, and lasted only a few minutes. On the morning of May 18 a terrible shock occurred. It suddenly shook down the walls of houses, tumbled down churches and the principal buildings, burying the citizens of the place in the ruins. Another shock completed the work of desolation. Three more shocks followed of equal intensity, but there appears to be no evidence that there were any openings in the earth, which on similar occasions have engulfed buildings and inhabitants, at least not in Cucuta. The shocks, with lesser force, however, seem to have been felt throughout the whole region of the earthquake for two days afterwards, extending to Cartagena and the western sea-coast. To add to the horror of the calamity, the Lobotera Volcano suddenly began to shoot out lava in immense quantities, or, as a correspondent writes, "it sent out a mass of molten lava in the form of incandescent balls of fire into the city."

Details concerning Mr. Giles's exploration of the country lying about 100 miles from the coast-line of the great Australian Bight have come to hand (see vol. xii. p. 135). The country he examined seems almost useless for pastoral purposes, the greater part of it being dense scrub, "heavy red sand-hills with thick mallee, mulga, acacia, Grevilles, casuaxina, hakea, and spinifex." For 200 miles the greatest suffering was endured from the want of water, the horses all dying, and the party only being saved by the camels; Mr. Giles speaks of the latter as "wonderful, awe-inspiring, and marvellous creatures." He just touched the edge of Lake Torrens, and from what he has seen he judges that there exists a vast desert of scrub of a triangular form, the base of which is at or near the western shores of the lake, and the sides running north-westerly from the southern foot, and most probably west from the northern cone to an apex at no great distance from his starting-point, Youldeh. It consists of two deserts divided by a strip of open country about thirty miles broad; the western one Mr. Giles has named Richards' Desert, and the eastern one Ross's Desert. His starting-point was Youldeh, 135 miles N.N.W. from Fowler's Bay. At Pyleburg, sixty-four miles from this, is an extraordinary native dam, and a clay tank, with circular wall five feet high around it, the work of the aborigines. Mr. Giles is confident of being able to cross to the settled district of Western Australia.

ADVICES from New Zealand represent the last shipment of salmon ova from Glasgow to that country as having arrived in a worthless state. The total length of time during which the eggs were packed on board ship was 121 days, or only nine days longer than the period during which it has already been proved by Mr. Buckland and Mr. Youl that the development of salmon may be safely retarded by ice. A large quantity of the ice remained till the end of the voyage, so that the temperature of the ice-houses must have been kept very low throughout the voyage. In fact it is said that the *exterior* of the packing never exceeded 43° Fahr. The officers of the Otago Acclimatisation Society state that microscopic examination proved that many of the eggs were unfertilised: but this was not the case with all; and it is hardly to be supposed that so experienced a pisciculturist as Mr. Buckland, who had charge of the operations of collecting and packing the eggs, could have improperly performed so important a duty. It is more than probable that of the large number of ova sent, many were handled by incompetent assistants. But this theory will not explain the want of vitality in the impregnated eggs, especially when the conditions for their safe transit were so favourable. The cases in which they were packed are described as "sodden," so that they did not suffer from dryness. It is probable, therefore, that want of ventilation was the cause of the failure of the experiment. It will be interesting to receive more detailed information from New Zealand, as our present advices hardly enable us to judge accurately of the state of the whole consignment.

AT the time of his death Dr. J. E. Gray had compiled a list of the books, memoirs, and miscellaneous papers of which, during his lengthy life, he had been the author. This Mr. J. Saunders has completed and seen through the press, a fitting last service to his illustrious chief. The total number is 1,162.

THERE is no professional branch of practice which is so much in need of elevation as the veterinary. On this account we feel particular pleasure in noticing the commencing number of a new monthly journal, the *Veterinary Journal*, conducted by Mr. George Flemming, of the Royal Engineers, whose valuable Manual of Veterinary Science and Police, as well as his other contributions to veterinary science, make it certain that the undertaking will not be found lacking in enterprise and the outspoken criticism of existing abuses. Messrs. Baillière, Tindall, and Cox are the publishers.

THE third part of the eleventh volume of the Transactions of the Zoological Society consists of a monograph by Prof. Owen on *Cnemiornis calcitrans*, the huge extinct Lamellirostral bird of New Zealand. We omitted to mention in connection with the preceding part of the same work that the monograph on the Birds of the Philippine Islands is by Lord Walden, President of the Zoological Society.

THE subscription for the families of the unfortunate aëronauts, Sivel and Crocé-Spinelli, has reached 3,200*l*. A monument will be erected by means of a special fund. The two aëronauts will be represented sleeping, wrapped in a large mantle, and the statue will be executed in marble, life size.

A VERY valuable publication is the "Seventh Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri," made to the State Board of Agriculture by Mr. Charles V. Riley, State Entomologist. It argues considerable enlightenment on the part of the Government of Missouri that they keep a State Entomologist, though Mr. Riley complains that his work is much hindered from want of sufficient funds. The necessity for such an official in Missouri is proved by the fact that a single insect, the Chinch Bug, filches nineteen million dollars from the pockets of the farmers in a single year, and reduces by so much the wealth of the State. "Yet, though the sum demonstrably amounts to millions," Mr. Riley states, "many of our legislators and some of our journalists would laugh at me were I to ask for an appropriation of five or ten thousand dollars to be expended in experiments which might result in giving us a perfect, or at least a much better remedy for the evil than any now in our possession, and thus save the whole or the larger part of this immense annual loss." In cases, as with the Locust, the Chinch Bug, the Cotton Worm, &c., where the evils are of a national character, Mr. Riley rightly advocates the appointment of a National Commission for the express purpose of their investigation, and consisting of competent entomologists, botanists, and chemists; and we are glad to learn that preliminary steps have been taken by some of the leading scientific men in the United States to memorialise Congress to create such a Commission, the members to be chosen by the Council of the National Academy of Science, and approved by the Secretary to the Treasury. The present Report is wholly occupied with the following noxious insects:—The Colorado Potato-Beetle, the Chinch Bug, the Flat-headed Apple-tree Borer, Canker-worms, the Grape Phylloxera, and the Rocky Mountain Locust.

THE U.S. Smithsonian Institution has lately undertaken an exploration which promises very important results in the interest of American archæology. It is well known that on some of the islands off the south coast of California there have been found some extremely interesting remains of prehistoric occupation on the part of the aboriginal tribes of the country, these consisting of stone implements in great variety, soap-stone bowls, bone and shell ornaments, &c., forming a valuable collection already obtained for the National Museum. With a view of exhausting the locality and securing whatever may still remain of interest, the services of Mr. Paul Schumacher, who had previously explored the region, have been secured by the Smithsonian Institution, and he left San Francisco early in May, with four labourers, for the scene of action. The U.S. Treasury Department gave him transportation on the revenue steamer *Rush*, and the War Department supplied tents and camp equipage. It is expected that this investigation will occupy several months, and that the results will be almost as interesting in their relations to American archæology as those of Di Cesnola in Cyprus, and of Schliemann in Troy, to that of the Old World. The special object of this investigation is the furnishing of material for the grand display to be made at the Centennial by the combined efforts of the Smithsonian Institution and the Indian Bureau.

THE Eighth Annual Report of the Trustees of Cambridge, U.S., Peabody Museum of American Archæology and Ethnology contains a memoir of Jeffries Wyman, the late Curator, to whom Mr. F. W. Putnam has succeeded. The Report contains besides some account of the additions made to the Museum since last Report, which are extensive and valuable. One of the principal additions is a collection of earthen dishes and vases, a number of bone and stone implements and miscellaneous articles from mounds near New Madrid, Missouri, and several stone implements from various localities in that State, collected by Prof. G. C. Swallow. This is a very important collection, particularly rich in articles of pottery and stone of the mound-builders. The Report contains a pretty full account of these with many illustrations, especially of articles of pottery of very varied and remarkable shapes. The mounds from which they were taken appear very ancient ; soil has formed on them to the depth of three feet, and the largest trees grow on them and the connected embankments or levees. Another large collection, by Mr. F. W. Putnam, comes from fortifications, caves, and mounds in Indiana and Kentucky, and consist of implements, weapons, pottery, sandals, bark-cloth, crania, &c.

MR. F. CLOWES, B.Sc., has been appointed Natural Science Master in the recently-established Middle Class Public School at Newcastle-under-Lyne. Mr. Clowes is the author of a work on Practical Analysis, and is well known as a sound and accurate chemist.

PROF. C. F. HARTT, of Cornell, U.S., has been appointed, with Major Continho, a Brazilian, to take charge of the Geological Survey of Brazil.

IT is estimated that 10,000,000 acres of land in Algeria are covered with a spontaneous growth of the Alpha plant. The exportation of this fibre for paper-making has increased very rapidly during the past five or six years. In 1869 it amounted to 4,000 tons, in 1870 it rose to 32,000 tons, and in 1873 to 45,000 tons, while the past year's produce was expected to reach 60,000 tons. The average price at Oran is about 140 francs per ton.

A VERY fine specimen of the singular rubiaceous epiphyte *Hydnophytum formicarium* has recently been received at the Kew Museum. This specimen measures some thirteen inches through, and was accompanied by some of the ants which make their nests in the fleshy tubers of the plant. These ants were very lively when received, and prove to be the *Camponotus irritans* of Smith.

PROF. BRADLEY, of Knoxville, Tennessee, has recently published the results of his geological labours among the Southern Appalachians, and they throw much light upon the probable age of the crystalline rocks of that region. It has long been the tendency of geologists to regard the metamorphic crystalline rocks of the Atlantic coast as certainly pre-Silurian. This has, however, been called in question by the observations of Prof. Dana, which go to prove that the limestones and accompanying schists and quartzites of Western New England are *all* Silurian, and not Huronian or Laurentian. Prof. Bradley now claims the same for the region he has investigated, that is, the western portion of North Carolina, the eastern part of Tennessee, and much of Georgia and Alabama. The evidence upon which the conclusion is based is stratigraphical, and must be studied in detail to be fully understood. The time at which the uplift and metamorphism of this region took place is considered by Prof. Bradley to have been post-carboniferous, and it is probably referable to the close of the palæozoic.

A VERY interesting and important addition to the ethnological branch of the National Museum at Washington, U.S., has lately been made in the form of a large collection of objects of stone from Porto Rico. This was gathered from the ancient graves of the island during a period of many years by Mr. George Latimer, an American citizen residing in that place. The most noticeable features in the series consist of about fifty oval stone rings of much the size and shape of horse-collars, all variously carved and ornamented. There are also many statuettes, carved heads, triangular stones with faces of animals carved at either end, some pottery, and numerous axes and chisels—some of exquisite beauty, and polished to the highest degree. Many of them are of the green jade so much sought after by archæologists.

MR. ELLIOT STOCK sends us an essay by Mr. T. K. Callard, F.G.S., on "The Geological Evidences of the Antiquity of Man reconsidered ;" being an attempt to show that man's antiquity is not so great as some eminent geologists make it to be, and that "man's advent was accompanied by the introduction of a vast number of fresh forms both in the vegetable and animal life, and that this took place soon after a great devastation of the former flora and fauna, which devastation was accompanied by ice and water."

THE *Electric News and Telegraphic Reporter* is the title of a new journal, edited by Mr. W. Crookes, F.R.S., to be published every Thursday. We wish it success.

THE sturgeon fisheries of Schleswig Holstein yielded 1,917 fish during 1874, of which 1,355 were caught in the Elbe, and 562 in the Eider. In 1873 the total was 2,174.

M. A. LANCASTER, of the Brussels Observatory, sends us a paper, reprinted from the *Bulletin* of the Belgian Academy, on the remarkable dryness of the months of February, March, and April of this year.

MR. ELLERY'S "Monthly Record of Results of Observations in Meteorology, Terrestrial Magnetism," &c., at Melbourne Observatory, for September and October, 1874, are to hand.

THE latest additions to the Manchester Aquarium include twelve Octopus (*Octopus vulgaris*) from the Channel Islands ; seven King, or Horse-Shoe Crabs (*Limulus polyphemus*) from North America ; twelve Large Spider Crabs (*Maia squinado*) from Devonshire ; two Lettered Terrapins (*Emys scripta*) from New Orleans ; two Salt-water Terrapins (*Malachlemys concentrica*) from Mexico ; one Horned Toad or Crowned Tapaxaxin (*Phrynosoma cornutum*) from Mexico ; one Alligator (*Alligator mississipiensis*) three feet long.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from India, presented by Lord Lindsay ; a Sloth Bear (*Melursus labiatus*) from India, presented by Mr. Richard A. Roberts ; three American Red Foxes (*Canis fulvus*) from N. America, presented by Mr. Edward Darke ; a Peregrine Falcon (*Falco peregrinus*), European, presented by Mr. H. J. Watson ; a Water Viper (*Cenchris piscivorus*) from N. America, presented by Mr. J. F. Painter ; a Gambian Goshawk (*Astur tibialis*) from W. Africa, purchased ; three Indian Adjutants (*Leptoptilus argala*), two Pondicherry Vultures (*Vultur calvus*), seven Indian Cobras (*Naia tripudians*) from India, deposited ; six Trumpeter Swans (*Cygnus buccinator*), a Common Fallow Deer (*Dama vulgaris*) born in the Gardens.

OUR BOTANICAL COLUMN

THE POTATO DISEASE.—It will be remembered by those of our readers interested in the potato disease, that Lord Cathcart offered a prize in 1873 for the best essay on the "Potato Disease and its Prevention ;" and it will also be fresh in their memories that of the ninety-four essays sent in, not one was considered by the judges to deserve the prize. This circumstance, and Prof. Dyer's summary of the history of what was known of the disease, delivered before the Horticultural Society last year, gave rise to some correspondence in this and other journals. Few subjects, probably, have been so fertile a source of wild theories and speculations. Mr. Eccles Haigh, one of the competitors for Lord Cathcart's prize, now comes before the public on his own responsibility, with a theory which at least has the merit of ingenuity, and is based upon a cleverly worked out idea. But it seems to us that the writer has taken up a wholly untenable position. In a pamphlet of forty-four pages, small octavo, the writer traces the causes not only of the murrain, in which *Peronospora infestans* is so destructive, but also of the "curl," a disease very prevalent just before the appearance of the present scourge, and, to his own satisfaction, explains how these diseases are to be prevented. To be brief, gardeners are credited with having induced by their mode of cultivation the "curl," and afterwards in getting rid of that, brought on the present far more formidable scourge. Mr. Haigh endeavours to show that during the "curl" period the potato bore enormous crops of berries, whilst since the prevalence of the murrain it has almost ceased flowering and fruiting; and in these facts (?) lies the whole gist of the matter. The production of fruit in profusion is regarded as an exhausting process so far as the tubers are concerned, and this is so far a very philosophic assumption, inasmuch as fruit-bearing is one of two ways to ensure the propagation of the plant. But here it becomes necessary to give the author's view respecting the "Functions of Nitrogenous Matter." It is in substance that the formation of fruit draws the nitrogenous matter from the plant and tubers, and when excessive crops of fruit are borne, the tubers are left without sufficient of this vital principle to continue the existence of the plant. On the other hand, when little or no fruit is produced, the tubers are left overcharged with this nitrogenous matter, which here becomes a source of decomposition, in proof whereof we are gravely told that the decay of manure is due to the presence of nitrogenous matter. It has long been admitted that excessive luxuriance predisposes in favour of disease; but this assumed presence of nitrogenous matter in the wrong place will hardly be accepted as an adequate explanation of the phenomena presented by the curl and the murrain. It is assumed that the potato left off bearing berries just about the time of the appearance of the murrain, and this we are told was brought about by the use of artificial manures containing a large percentage of nitrogenous matter. The "curl" was cured or rather prevented by using sets (tubers) from plants which had not been allowed to ripen seed. We have not space to examine the writer's arguments in support of this theory, but we may give his remedy.

"Having so fully set forth the natural habit of the plant, and so copiously elucidated the principles on which my theory of the disease is founded, the means of its prevention all but suggest themselves. They require compliance with but two simple forms: regenerate through the seed two or three times, and abstain as nearly as practicable, not only from nitrogenous artificial manures, such as guano, sulphate of ammonia, rape-cake, nitrate of soda, but also from strong farmyard manure."

We do not intend to attempt to refute the author in detail here, as it would occupy too much space; but we may observe that the condition of practical experience imposed upon the competitors for the Cathcart prize, of which our author complains because it disqualified him, was the wisest provision in the whole business. It is just this want of practical experience and personal knowledge that has led him astray in regard to the berry-producing power of varieties now cultivated, of the description of manure usually employed, &c. Why all varieties of the potato in all parts of the kingdom should have become just so much overcharged with nitrogenous matter at exactly the same time as to take the disease is rather puzzling. Does the writer not know that the Vine Mildew, *Oidium Tuckeri*, has been successfully combated?

Since the preceding lines were written, the report of a new (?) disease having attacked the potato-crop has caused some consternation and alarm. First we hear that it has destroyed the entire crop of American varieties in the trial gardens of the Horticultural Society at Chiswick; then the appearance of the same disease is observed in Northumberland, but here again only American varieties are affected, and a vain hope is indulged in that it may soon be stamped out. The following week, however, the horticultural journals begin to team with letters from the most distant parts, and the unwelcome truth that all varieties are alike attacked, or liable to be attacked, is forced upon us. True, we read of certain varieties being diseased, whilst others remain healthy in the same garden, but we fear there is no ground for believing that it is restricted to any particular varieties, whether of English or American origin. The Rev. M. J. Berkeley is investigating the nature of the disease, which he regards with considerable anxiety. It appears to be caused by, or perhaps succeeded by, a fungus growth. At all events a fungus is present; but we must await a thorough microscopical examination for more precise information. Mr. Shirley Hibberd, in a letter to the editor of the *Times*, takes a more hopeful view of the matter than we can; and his description of the nature and spread of the disease is not borne out by the reports from other quarters. His statement that the new disease begins in the "set" and progresses upwards, is in direct contradiction to the experience of others. In the *Gardener's Chronicle* it is affirmed that the sets of affected plants were cut in two, and in no case was there the slightest evidence of disease in the tuber causing immature and diseased haulm. Possibly, however, it may manifest itself in different forms.

SCIENTIFIC SERIALS

THE *Journal of the Chemical Society*, April and May.—The April number contains the following papers:—Researches on the paraffins existing in Pennsylvanian petroleum, by Thos. M. Morgan. This paper is followed by some remarks on the same subject by Prof. C. Schorlemmer.—On Groves' method of preparing chlorides, by the same.—A note on aricine, by David Howard.—On the precipitation of metals by zinc, by J. L. Davies. The author failed to precipitate to any large extent many of the metals which, according to some metallurgical books, are precipitated by zinc from acid solutions. Copper and the other well-known metals reduced by zinc precipitate well enough, but nickel, cobalt, iron, &c., do not. If, however, ammonia was added to their solutions the precipitating power of the zinc was rendered as efficient as under ordinary circumstances it is with copper, &c. The zinc was used in the shape of filings, and the author remarks that the metals precipitated by it under the above circumstances present a beautiful metallic appearance, and are in a weighable form.—On the action of the organic acids and their anhydrides on the natural alkaloids (Part III.), by G. H. Beckett and C. R. Alder Wright. The authors in this paper treat first of the action of acetic anhydride on the polymerides of codeine and morphine (dicodeine, tetracodeine, and tetramorphine being considered, further also the action of ethyl iodide on tetracodeine and octacetyl-tetracodeine); they then speak of isomeric diacetyl morphines, and of the action of ethyl iodide on acetylated morphine, codeine derivatives, and analogous products. The compounds treated of in the latter division are diacetyl-codeine ethiodide, tetracetyl-morphine ethiodide, α-, β-, and γ-diacetylmorphine ethiodide, dibutyryl-codeine ethiodide, tetrabutyrylmorphine ethiodide, dibutyryl-morphine ethiodide, dibenzoylcodeine ethiodide, tetrabenzoyl-morphine ethiodide, and α diacetyl-dibenzoyl-morphine ethiodide. Finally, there is an account of the action of ethylate of sodium on acetylated codeine and morphine.—The *Journal*, as usual, contains numerous abstracts from other serials.—The May number contains the following papers:—Further researches on bilirubin and its compounds, by Dr. J. L. W. Thudichum. This is a most elaborate paper, and we must refrain from entering on its details, confining ourselves to a mere outline of its contents. First, the author gives an account of the behaviour of bilirubin with the halogens, and in turn speaks of mono- and dibromo-bilirubin, the tri- and tetrachloro-bilirubin (with iodine there is no reaction at 80° to 100°). Then Dr. Thudichum proceeds to consider the operations made by chemists on bilirubin, prior to his own. He then describes some experiments bearing upon the alleged transformation of bilirubin into the colouring matter of urine, and treats of Maly's hydrobilirubin, urochrome spectra, and the spectra of the chemolytic products of bilirubin. We then have an account of experiments made with Jaffé's product, with which Maly compared his biliary product more particularly. Jaffé's product was obtained from febrile persons, and Dr. Thudichum points out that a source of error must here be eliminated, namely, the abnormal product urerythrin. He gives the spectrum and a new reaction of this compound; finally, there is a note on Jaffé's urobilin. The paper ends with a summary of conclusions *against* the alleged metamorphosis, and with some remarks on the author's theory of bilirubin and bilirubates, and on Städeler's hypothesis regarding the same.—On calcic hypochlorite from bleaching powder, by Charles T. Kingzett. This treatise turns on the chemical constitution of bleaching powder, on which subject the opinions of eminent chemists are at variance. The author describes four experiments which he made with a view to bring light into the matter, but he was not completely successful. Although his experiments may be regarded as a perfect proof of the body being in mass hypochlorite of calcium, yet he is nevertheless reluctant in being too positive on the subject, and recommends further investigation.—On a simple method of assaying iron, by Walter Noel Hartley. The principles on which this method depends are (1) The abolition of weights by exactly balancing a quantity of the ore to be examined against pure iron wire. (2) The reduction of inaccuracies in weighing by making the solutions of the iron and the ore up to the same volume, and taking a fraction (about $\frac{1}{50}$) of the liquid for experiment, whereby the error of the balance is diminished $\frac{1}{50}$. (3) The reduction of all other experimental errors to a minimum by putting comparable quantities of both ore and pure iron under precisely the same conditions. There is the usual number of abstracts in this part.

THE *Geographical Magazine*, July.—This is a particularly interesting number of this magazine. The first article is an abstract of the narrative of Captain the Hon. G. C. Napier, who has recently returned to India after an adventurous tour in Northern Persia. An article on "Recent Russian Explorations in Western Mongolia," accompanied by a map, gives some account of (1) Sosnovski's and Miroshnichenko's explorations on the Upper Irtysh in 1872–73; (2) Matusovski's journey into the Ektag-Altai in 1873; (3) A Russian caravan journey to Kobdo, Uliassutai, and Baikul in 1872. In an article on Paraguay the leading features of the history of that country are traced. In "A Trip up the Congo or Zaire" river, Selim Agha gives an interesting account of his journey from Fernando Po to that river in company with Capt. Burton; the latter prefaces the narrative with a few words of personal notice of his old factotum and companion. To those whose interest in Zanzibar has been awakened by the present visit of its sovereign to this country, the account of the dominions of the Seyyid Burghash, along with the good map which accompanies it, will be welcomed. The usual reviews and reports fill up the number.

Journal of Proceedings of the Winchester and Hampshire Scientific and Literary Society, vol. i. part iv., 1874.—We are glad to see from the president's address that this Society is doing much real work, and especially that it is devoting itself with considerable zest and good results to field-work. The Society includes in its programme a wide variety of subjects, and its Journal contains good papers in various departments of science. The president, the Rev. C. Collier, after reviewing the Society's work for the year, gives an interesting address on the archæology of Winchester and its neighbourhood. Other papers in the part are "Selections from the Sanskrit Poets," by Mr. W. Waterfield; "Sarsens, greywethers, or Druid Stones," by Mr. Joseph Stevens; "Two-winged Plagues," a paper on Œstrids, Tabanids, and Hippoboscids, by the Rev. W. W. Spicer; "The Chalk Formation," by Mr. C. Griffith; and "A Gossip about Mites," by the Rev. W. W. Spicer.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, May 1.—This number contains an account of Mr. Colding's work on the behaviour and relations of atmospheric currents, consisting mainly of mathematical reasoning based upon a study of the movements of water, which he considers analogous to those of air. With regard to hurricanes, he observes that just as in a water eddy the velocity of rotation increases from the circumference towards the centre, until at the inner surface it becomes imaginary, so the velocity of the wind increases from the circumference of a revolving storm towards the centre, but at a certain distance from the centre, the boundary of the calm space, falls suddenly to stillness. He believes the following formula, which applies to water, to be good for air also, both being bounded by a resisting medium. Let water circulate in a cylinder, where H = depth of current at the circumference, V = velocity of current at the surface; then at a depth x below the surface:

$$v = V\left(1 - 0{\cdot}433\left(\frac{x}{H}\right)^{\frac{3}{2}}\right)$$

when the resistance at the base is equal to that which would be exercised by a substratum of water. If water flows in at one point in a vessel containing water, and flows out at another point, and the inflowing and outflowing quantities are equal, the surface remains at a constant level. Let the supply be in the middle and the outflow round the circumference, the water will descend towards the circumference. If the contained water be rotatory, its condition will be similar when a constant stream flows in; there will be an increase of pressure at all points, and the water will attain a higher level, descending in the directions of its escape. A whirlwind can withstand pressure from without only when the rotation has a certain velocity, and although a considerable quantity of air must flow to the whirlwind along the surface of the earth, on the other hand a permanent current must flow outwards in the direction of the surface level. In moving over the surface of the earth it encounters many obstacles, which reduce the velocity of rotation, so that an inrush of the air at higher pressure takes place, and immediately the condensed air in the lower strata forces outwards a quantity of air at the top proportionate to that which streams towards the centre below. This action of course diminishes the fury and increases the diameter of a hurricane, and exhibits the twisting motion so often observed in small whirlwinds and waterspouts. The rest of the article will be given in the next number of the *Zeitschrift*.

Der Naturforscher, May 1875.—From this part we notice the following papers:—On the atomicity of nitrogen, by Victor Meyer and M. Lecco. These gentlemen arrive at the conclusion that nitrogen is not a triad, as thought by some chemists, but a pentad.—On the process of fertilisation with fungi (Basidiomycetes) by Van Tieghem.—On the evaporation of moisture through the human skin, by Fried. Erismann.—On the cause of luminosity or non-luminosity of carboniferous flames, by F. Wibel.—On the artificial imitation of native polar-magnetic platinum, by Daubrée.—On the tenor of nitrogen in soil-acid, by E. Simon.—On the behaviour of some solutions in polarised light, by O. Hesse.—On the marine flora existing at Spitzbergen during winter, by Herr Kjellman.—On the temperatures in the southern and northern Atlantic Ocean, by Herr von Schleinitz.—On melting points, by Herr Müller.—On the dependence of the action of emulsine upon physical conditions, by Herren E. Marckurst and G. Hüfner.—On hardened glass, by Herr Bauer.—On the so-called "Riesenkessel" (gigantic kettles) near Christiania and their origin, by Herren Brögger and Reusch.—On the immunity of *Gymnotus electricus* against its own electric shock, by Herr J. Steiner.—On the influence of light on the weight of animals, by Dr. Fubini.—On the dependence of the specific heat of carbon, boron, and silicon upon temperature, by Friedrich Weber.—On the action of the central organs of the nerves, by Herr Frensberg.—On the spectrum of Encke's comet, by Herr von Konkoly.—On the action of the electric current on fused amalgama and alloys, by Eugen Obach.

Monthly Notices of Papers and Proceedings of the Royal Society of Tasmania for 1873.—This has only just come to hand, and the subject matter of some of the papers has lost in interest, inasmuch as some of the phenomena discussed—the Transit of Venus, for instance—have since taken place. Mr. F. Abbot's paper on the Transit of Venus, with special reference to the importance of determining the true distance of the sun in connection with meteorology, is a most interesting contribution. Speaking of the effects of conjunctions, he alludes to the fearful storm which took place Nov. 27, 1703, when five of the planets were in conjunction. The storm swept over the continent of Europe, causing an immense amount of damage. It was on that day the whole structure of the first Eddystone Lighthouse, together with its architect, Winstanley, and other inmates, was blown into the ocean.—The principal other contributions are on the Mersey coal-measures, by T. Stephens, M.A.; on the Tertiary Beds in and around Launceston, by R. M. Johnston; Contributions to the Phytography of Tasmania, by Baron F. Mueller; and Law of Weather and Storms, by the Right Rev. Bishop Bromby.

Reale Istituto Lombardo.—Rendiconti: vol. viii., fasc. x. and xi.—These parts contain the following papers:—On scientific association, by Prof. G. Sangali.—On the "Jaborandus," by Prof. S. Garovaglio.—On the importance of the study of meteorology to agriculturists, by Prof. Gaetano Cantoni.—On the reasons why sulphur destroys the *Oidio* (a cryptogamic parasite) of the vine, and on the emission of free hydrogen from plants, by Prof. E. Pollacci.—On two questions relating to chimneys, by Prof. R. Ferrini.—On hydrostatic pressure in relation to the molecular motion of gravitation, by Dr. G. Grassi.—The remaining papers in this part relate to political and moral sciences.

THE *Journal de Physique Théorique et Appliquée*, May 1875, contains the following original papers:—Researches on the modifications which light undergoes in consequence of the motion of the luminous source and of that of the observer, by M. Mascart.—On the currents of mechanical origin, by E. Bouty.—On the combustion of explosive mixtures, by M. Neyreneuf.—On the apparatus used for the explanation of the laws and formula of elementary optics, by C. M. Gariel.—On the determination of the electric capacity of bodies and of their condensing power by means of Thomson's electrometer, by M. A. Turquen.—A note by M. C. Daguenet, on the electric light in rarefied gases.

Verhandlungen des Vereins für Naturwissenschaftliche Unterhaltung zu Hamburg, 1871–74.—This is the Vereins' first publication, and contains an account of the formation and of the first year's doings of the Society, together with a copy of the laws and regulations, and a list of members. Further on we have several well-written articles, viz.:—On the preparation of caterpillars for collections, by G. J. Wittmack.—On some attempts at silk-culture with *Bombyx mori*, by Georg Semper.—Researches on the effects of trichinæ on white rats, by C. Rodig.—On a method of preparing slugs for dry keeping in collections, by F. Hübner.—Geological recollections of a few weeks at Weymouth, by Dr. Filby.—Some remarks on *Cypraeæ*, by Dr. Aug. Sutor. On the homoptera of Schleswig, by Dr. H. Benthin.—Finally, there are a number of papers relating to the fauna of the Lower Elbe, some of which are highly interesting.

THE March number of the *Bulletin de la Société d'Acclimatation de Paris* contains, among other papers, one by M. E. Renard, on a new kind of bamboo, and the articles made from the canes of this species of plant. This particular variety is square, and is found in the Chinese provinces of Honan and Se-tchuen.—M. le Comte Pouget, in a note on the Kagou, describes a new bird known by that name in New Caledonia, of which it is a native, and called *Rhynochetos jubatus* by ornithologists. The bird is entirely insectivorous, feeding on almost every kind of insects and worms, and appears to thrive in the climate of France.—M. Gildas, a priest in the monastery of Nôtre Dame de la Trappe des Trois Fontaines, near Rome, gives a description of the growth of Eucalyptus trees in the Roman Campagna; the salubrity of the locality has, partly in consequence of sanitary works, and partly probably in consequence of the effect of these trees, been greatly increased of late years.—The Colorado potato beetle (*Doryphora decemlineata*) is being made the object of special research by members of the Society. M. Maurice Girard states that as this insect does not exist always in close contact with the plant on which it lives, it will probably suffer from the change of climate to which it is subjected by transportation from America to Europe, and will consequently die off. Had it been, like the Phylloxera, an insect living always closely fixed to the tree on which it preys, there would have been greater danger of its permanent introduction into other countries.

SOCIETIES AND ACADEMIES

LONDON

Anthropological Institute, June 22.—Col. A. Lane-Fox, president, in the chair.—A paper by Mr. Herbert Spencer was read on the comparative psychology of man. The author commenced by showing the necessity for division of labour in a systematic study of psychology, and proceeded to map out the subject into divisions and subdivisions, and to indicate the manner in which its various branches might be investigated. The main divisions were—mental mass and complexity, the rate of development, plasticity, variability, impulsiveness, difference of sex, the sexual sentiment, imitation, quality of thought, peculiar aptitudes, with their many subdivisions. Mental effects of mixture, and the inquiry how far the conquest of race by race has been instrumental in advancing civilisation, would also come within the scope of comparative psychology.—Mr. John Forrest read an account of the natives of Central and Western Australia, whom he had observed during two journeys he had made across the country from Western to South Australia. Among their customs might be mentioned that of tattooing on the shoulders, back, and breast, and the practice of boring noses, which is raised to the importance of a ceremony, when hundreds of individuals gather together for that object. Circumcision he found to be universal. The use of the boomerang was described, and the exaggerated statements concerning the manipulation of the weapon were corrected. Cannibalism was common among the natives of the interior. Many other descriptive details of their faith, manners, and customs were given.—A paper by Capt. John A. Lawson was read on the Papuans of New Guinea. The only part of the coast that the author examined was Houltree, and there, as in the interior, he met with a race of people dissimilar to those described by other travellers who have visited various parts of the coast. There was a marked diversity in stature; in the south of the island the people were shorter than those inhabiting the north. They were possessed of enormous muscular power, and showed a large thoracic development. Their complexion was a dark tawny, but not black, and their features were of Negroid type.

Royal Horticultural Society, June 2.—Scientific Committee.—J. D. Hooker, M.D., C.B., P.R.S., in the chair.—Prof. Thiselton Dyer made some further remarks on *Tetranychus Taxi*, A.Murr., which he thought did not attack the ordinary buds of the Yew, but, as far as he had observed, those containing the female flowers. The acarus appeared to feed on the nucleus of the ovule and the adjoining scales, the external scales became brown and withered.—The Rev. M. J. Berkeley showed specimens of *Hypoxylon octraceum*, which was figured by Bulliard, tab. 444, fig. 3. It had been referred by Fries to *Lophium mytilinum*, but was really, as Sowerby was aware, the cocoon of a midge. Mr. Berkeley had met with similar cocoons belonging to other species, and Prof. Westwood was understood to be preparing descriptions of all three.—Prof. Thiselton Dyer exhibited specimens of the capsules of *Hibiscus Rosa-sinensis*, which, though the plant was so common in gardens, were quite undescribed. According to Dr. Cleghorn, it rarely if ever fruited in India. In Barbados, on the other hand, it fruited abundantly in the garden of General Munro.—Mr. Andrew Murray read a paper on the packing of living plants for transport.—Prof. Thiselton Dyer called attention to Willkomm's "Die mikroscopischen Feinde des Waldes," in which the Larch-canker was shown to be due to the attacks of the so-called "*Corticium amorphum*," since described by Hartig as *Peziza Willkommii*.

General Meeting.—W. Burnley Hume in the chair.—The Rev. M. T. Berkeley called attention to the more interesting objects exhibited. The young shoots of apple-trees were liable to great injury from an *Oidium*, which might, however, be destroyed by the use of sulphur; specimens were exhibited.

June 16.—Scientific Committee.—A. Murray, F.L.S., in the chair.—A letter was read from the Hon. Secretary of the Wiltshire Horticultural Society relating to some diseased potatoes, upon which Mr. Berkeley remarked that he had recently found the American varieties at Chiswick, especially the Early Rose, dreadfully affected with disease, communicated from the tuber to the haulm. Mr. Berkeley had hitherto been only able to make a superficial examination, but he suggested that possibly the disease in question was analogous to the "curl," a disease well known many years ago, but since then not noticed. He had found in the cells of the leaf an obscure fungoid organism—a species of *Protomyces*.—Mr. Bateman exhibited a package of the Paraguay tea, *Ilex paraguayensis*, together with the gourd and strainer used by the natives in the preparation of this tea, as figured in Hooker's *Journal of Botany* many years since.—Mr. W. G. Smith exhibited a drawing of the mould (*Ascomyces deformans*) which is associated with the Peach blister.—Dr. Masters exhibited on the part of the Rev. H. N. Ellacombe a portion of the main root of an apple nearly gnawn through by the Water Vole. Dr. Masters also showed *Cheiranthus Cheiri* var. *gynantherus*, to show that the peculiarity was reproduced from seed.—Dr. Hooker sent for exhibition the nest of a trap-door spider found in the bark of a tree at Uitenhage, Port Elizabeth, South Africa, where it was obtained by Mr. Bidwell, a member of the Legislative Assembly of Cape Town. The nest and the lid were so nearly like the bark itself that it was with difficulty the lid could be seen, and it was with some difficulty that the lid could be raised, as the insect was still within the nest. Mr. Murray suggested that the spider had taken possession of the empty cocoon of a moth (*Bombyx*), and had woven a lid to it with silk and fragments of bark.

General Meeting.—Hon. and Rev. J. T. Boscawen in the chair.—The Rev. M. J. Berkeley gave an account of the new potato disease, which he identified (as mentioned above) with that formerly known as the "curl."

PHILADELPHIA

Academy of Natural Sciences, Sept. 22, 1874.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy remarked that he had found several specimens of the curious rhizopod, discovered by Cienkowski, and named by him *Clathrulina elegans*. They were found among Utricularia, but though retaining their stems, were unattached and apparently dead. One of the specimens presented a peculiar and as yet unexplained character. On one side of the latticed head the orifices were capped with little inverted hemispherical cups, from the top of which projected a funnel like the cup of the spongozoa. Prof. Leidy was pursuing his search for the living and attached Clathrulina.—Prof. Leeds made some remarks concerning a remarkable mineral found in a bank of white sand near Fayetteville, N.C. It was, in appearance, a rod of glass four feet in length and two inches in diameter, which was made up of a great number of irregular fragments. These fragments were highly polished on one side, the side apparently turned towards the hollow axis of the rod, and excessively contorted on the exterior side. They consisted almost entirely of silex, the remainder being chiefly oxide of iron. Accurate analysis showed that the percentages of the constituents in these siliceous fragments and in the sand found in the hollow core of the rod were the same. On account of this identity in composition, and the incompetency of any other known agent to produce such a fusion of almost pure silex, it was concluded that this "rod of glass" was a result of lightning—a lightning-tube, or fulgurite, as such products have been called.—Mr. Thomas Meehan referred to a former communication in which he exhibited specimens of *Euphorbia cordata*, or *E. humistrata*, collected by him in the Rocky Mountains, and which, normally procumbent, had assumed an erect habit on being attacked by a fungulus, *Æcidium euphorbiæ hypericifoliæ*. He now found that the common trailing Euphorbia of our section, *E. maculata*, when attacked by the same fungulus, assumed the same erect habit. With change of habit of growth there was a whole change in specific character in the direction of *E. hypericifolia*.

Sept. 29.—Dr. Ruschenberger, president, in the chair.—On favourable report of the committee to which it was referred, the following paper was ordered to be printed:—"Notes on the Santa Fé Marls, and some of the contained Vertebrate Fossils," by E. D. Cope.

Oct.—Mr. Thomas Meehan introduced a specimen in which plants of *Triticum* and *Bromus* were blended. This Dr. J. G. Hunt proved to have been a "cheat;" neither did he think the workman had been expert in his manipulation.—Mr. Redfield drew attention to the growth, near Delaware River, of *Polygonum orientale* and *Cleome pungens*, which Prof. Leidy traced to ballast deposited there. The lastnamed author then drew attention to some new species of *Difflugia*. —Mr. Meehan announced the discovery of *Abies concolor* in Glen Eyrie, Colorado, by Dr. Engelmann; and Prof. Leidy drew attention to the devastation of the oaks of New Jersey, by the *Dryocampa senatoria*.

Nov.—Mr. A. R. Grote presented a paper on a new species of *Nocteridæ*, describing as new genera and species *Acronycta exilis*, *A. paupercula*, *Eutolype*, *Himella*, &c.; and Prof. Cope described some ruins of villages of extinct races near Nacimiento, N.M.—Prof. Leidy, besides referring to *Titanotherium*, drew attention to several Protozoa which he was studying, including species of *Clathrulina elegans*, *Amœba viridis*, &c.—Prof. P. Frazer, jun., described the geology of certain lands in Ritchie and Tyler Counties, W.V.; and Dr. Elliott Coues read a synopsis of the *Muridæ* of North America, dividing the Murinæ into the genera *Mus*, *Neotoma*, *Sigmodon*, *Hesperomys* (Waterhouse, emend.), *Ochetodon* (n.g.); and the Arvicolinæ into *Evotomys* (n.g.), *Arvicola*, *Synaptomys*, *Myodes*, *Cuniculus*, and *Fiber*.

VIENNA

K. K. geologische Reichsanstalt, Jan. 5.—This was a festival meeting in celebration of the 25th anniversary of the foundation of this institution. No scientific papers were read. From those read at the subsequent meetings, Jan. 19, Feb. 16, March 2 and 16, we note the following:—Geological report from travellers in Persia, by Dr. E. Tietze.—On the Aralo-Caspian basin, by Dr. M. Neumayr.—On some pseudomorphous copper ores from the Ural, by E. Döll.—On well-sinking in the Vienna district, by T. Fuchs. —On Tertiary stone formations in Carniola, by the same.—On the formation of terra rossa, by Dr. Neumayr.—On a new occurrence of manganic peroxide in Lower Styria, by Dr. R. v. Drasche.—On the gneiss formation of the Bohemian forest, by Dr. J. Woldrich. —On the geological results of the railway diggings between Rakonitz and Beraun, by H. Wolf.—On the occurrence of antimony near Eperies, by L. Manderspach.—On the ores of Laurion in Attica, by A. Schlehan.—On some new silver ores from Joachimsthal, by J. v. Schröckinger.—On the lime of the Acropolis of Athens, by Dr. M. Neumayr.—On the environs of Predazzo and on the Monzoni mountains, by Dr. C. Doelter.—On the interior structure of the Offenbánya mining district and on that of the Boitza district, by F. Posepny.—On some petrifactions from the Kalnik mountains, by Dr. R. Hörnes.—On some slaked stone mounds in Bohemia, by Dr. J. Woldrich.

PARIS

Academy of Sciences, June 28.—M. Frémy in the chair.—The president welcomed M. Janssen in the name of the Academy on his return to Paris, and M. Janssen made some remarks in reply.—The following papers were read:—On the explanation of numerous phenomena which are consequences of old age, by M. Chevreul.—On the work in course of execution at the Observatory, by M. Leverrier. Among other observations it is proposed to carry on a series with a view to constructing magnetic and meteorological charts of France.—Magnetic observations made in the Peninsula of Malacca, by M. Janssen. The observations were undertaken with a view to fixing the present position of the magnetic equator, which the author found to pass between Ligor and Singora. A meridian was found also in which the magnetic declination was 0°. This note is dated from Singapore, May 16.—On the distribution of magnetism in a thin bar of great length, by M. J. Jamin.—On the cyclone at Châlons; second examination of facts and conclusions, by M. Faye.—On the distribution of an acid among several bases in solutions, by M. Berthelot.—On the hydrocarbons produced by the distillation of the crude fatty acids in presence of superheated steam, by MM. A. Cahours and E. Demarcay. The authors found in a sample of oil from Fournier's stearine candle factory the following hydrocarbons: amyl, hexyl, and heptyl hydrides; likewise the hydrides of octyl, nonyl, decyl, undecyl, duodecyl, and cetyl.—Note on tabular electro-magnets with multiple cores, by M. T. du Moncel.—Note accompanying the presentation of the first volume of the "Analytical and Experimental Demonstration of the Mechanical Theory of Heat," by M. Hirn.—Influence of compressed air on fermentation, by M. P. Bert.—Memoir on the earth's motion of rotation, by M. E. Mathieu.—Study of electric discharges through fine metallic wires, by M. Melsens.—On the influence of magnetism on the extra current, by M. Trène.—Chemical equivalence of the alkalies in the ashes of various vegetables, by MM. Champion and H. Pellet.—On the presence of hydrogen dioxide in the sap of vegetables.—On the work of the expedition commissioned to study the project of a central sea in Algeria, by M. Roudaire.—Solar parallax deduced from the combination of the Noumea with the Saint-Paul observations, by M. C. André.—On the numerical values of the musical intervals in the vocal chromatic gamut, by M. Bidault.—New sounding flames, by M. C. Decharme.—Action of chlorine on isobutyliodhydric ether, by M. Prunier.—On the portative force of M. Jamin's magnets, by M. A. Sandoz.—New apparatus relating to respiration, by M. G. Carlet.—Of the influence of the noxious *Solanaceæ* in general, and of belladonna in particular, on Rodents and Marsupials, by M. E. Heckel.

BOOKS AND PAMPHLETS RECEIVED

AMERICAN.—The Birds and Seasons of New England: Wilson Flagg (Trübner and Co.)—Annual Report of the Board of Regents of the Smithsonian Institution (Washington).—Important Physical Features exhibited in the Valley of the Minnesota River. An Essay, by G. K. Warren (Washington).—Proceedings of the American Philosophical Society.—Transactions of the Academy of Science of St. Louis. Vol. iii. No. 2.—Bulletin of the Essex Institute, 1874.—Report of the Geological Survey of Missouri, U.S., and Atlas to same

FOREIGN.—Notizblatt des Vereins für Erdkunde. 3te Folge, 13tes Heft (Darmstadt)—Nach den Victoriafällen des Zambesi, von Eduard Mohr. 2 vols. (Berlin, Ferdinand Hirt und Sohn).

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THURSDAY, JULY 15, 1875

SCIENTIFIC WORTHIES

V.—GEORGE GABRIEL STOKES

A GREAT experimental philosopher, of the age just past, is reported to have said, "Show me the scientific man who never made a mistake, and I will show you one who never made a discovery." The implied inference is all but universally correct, but now and then there occur splendid exceptions (such as are commonly said to be requisite to prove a rule), and among these there has been none more notable than the present holder of Newton's chair in Cambridge, George Gabriel Stokes, Secretary of the Royal Society.

To us, who were mere undergraduates when he was elected to the Lucasian Professorship, but who had with mysterious awe speculated on the relative merits of the men of European fame whom we expected to find competing for so high an honour, the election of a young and (to *us*) unknown candidate was a very startling phenomenon. But we were still more startled, a few months afterwards, when the new professor gave public notice that he considered it part of the duties of his office to assist any member of the University in difficulties he might encounter in his mathematical studies. Here was, we thought (in the language which Scott puts into the mouth of Richard Cœur de Lion), "a single knight, fighting against the whole *mêlée* of the tournament." But we soon discovered our mistake, and felt that the undertaking was the effect of an earnest sense of duty on the conscience of a singularly modest, but exceptionally able, and learned man. And, as our own knowledge gradually increased, and we became able to understand his numerous original investigations, we saw more and more clearly that the electors had indeed consulted the best interests of the University; and that the proffer of assistance was something whose benefits were as certain to be tangible and real as any that mere human power and knowledge could guarantee.

And so it has proved. Prof. Stokes may justly be looked upon as in a sense one of the intellectual parents of the present splendid school of Natural Philosophers whom Cambridge has nurtured—the school which numbers in its ranks Sir William Thomson and Prof. Clerk-Maxwell.

All of these, and Stokes also, undoubtedly owe much (more perhaps than they can tell) to the late William Hopkins. He was, indeed, one whose memory will ever be cherished with filial affection by all who were fortunate enough to be his pupils.

But when they were able, as it were, to walk without assistance, they all (more or less wittingly) took Stokes as a model. And the model could not but be a good one: it is all but that of Newton himself. Newton's wonderful combination of mathematical power with experimental skill, without which the Natural Philosopher is but a fragment of what he should be, lives again in his successor. Stokes has attacked many questions of the gravest order of difficulty in pure mathematics, and has carried out delicate and complex experimental researches of the highest originality, alike with splendid success. But several of his greatest triumphs have been won in fields where progress demands that these distinct and rarely associated powers be brought simultaneously into action. For there the mathematician has not merely to save the experimenter from the fruitless labour of pushing his inquiries in directions where he can be sure that (by the processes employed) nothing new is to be learned; he has also to guide him to the exact place at which new knowledge is felt to be both necessary and attainable. It is on this account that few men have ever had so small a percentage of *barren* work, whether mathematical or experimental, as Stokes.

Like that of the majority of true scientific men, his life has been comparatively uneventful. The honours he has won have been many, but they have never been allowed to disturb the patient labour in which short-sighted Britain has permitted (virtually forced) him to waste much of his energies. He was born on August 13, 1819, at Skreen, Co. Sligo, of which parish his father was rector. At the age of 13 years he was sent to Dublin, where he was educated at the school of the Rev. R. H. Wahl, D.D. In 1835 he was removed to Bristol College, of which Dr. Jerrard was principal. He entered Pembroke College, Cambridge, in 1837; graduated in 1841 as Senior Wrangler and First Smith's Prizeman; became Fellow of his College in the same year; and in 1849 was elected Lucasian Professor of Mathematics. In 1857 he vacated his fellowship by marriage, but a few years ago was reinstated under the new statutes of his college. Stokes was elected Fellow of the Royal Society in 1851, was awarded the Rumford Medal in 1852, and was elected Secretary of the Society in 1854.

A really great discoverer in mathematics or physics does not seek the readily-accorded plaudits of the ignorant masses or of the would-be learned rich. He knows the worthlessness of such verdicts (in any but a possible pecuniary sense); his joy is in the conviction that, within a very short time after their publication, his discoveries will be known to all who are really capable of comprehending them; that his experiments will be repeated, and in many cases even extended, by some of them before he has made further advance. He is a true soldier of science, and fights for her cause, not for his own hand; he joys quite as much in an advance made by another as in his own. When the army has passed on from the well-fought field, let the camp-followers deck themselves with frippery from the spoil, and talk pompously of the labours of the campaign! Them the many-headed will applaud, too often even sage rulers will lavishly reward them. The true votary of science, in this country at least, rarely meets with State encouragement and support. Mole-eyed State! Men whose undisturbed leisure would be of incalculable value, not only to the instruction but to the material progress of the nation, have to devote the greater part of their priceless intellects and time to work like common hodmen for their children's bread! It is the long-consecrated, and still common, custom of our mighty empire to harness Pegasus to the dust-cart! Ignorance alone is to blame for this, ignorance that cannot distinguish Pegasus from a jackass!

Perhaps the simile may be thought exaggerated. But what a comment on things as they are is furnished by the spectacle of genius like that of Stokes' wasted on the drudgery of Secretary to the Commissioners for the University of Cambridge; or of a Lecturer in the School of Mines; or the exhausting labour and totally inadequate remuneration of a Secretary to the Royal Society! Men know about these things, as well as about a good many other important things, much better in Germany than we yet know them; and it will not be very long before we in our turn will be forced to know them to the full as well. Let us hope that this knowledge may come to us in a more gentle form than that of the rude and sudden lessons which have so lately been read (for something very like the same fatal blindness) alike to Austria and to France!

The magnificent Royal Society *Catalogue of Scientific Papers*, one of the greatest boons ever conferred on men of science, shows that up to 1864 Stokes had published the results of some *seventy* distinct investigations; on an average between three and four per annum. Several of these are controversial; designed not so much to establish new results as to upset false and dangerously misleading assertions. Some are improvements on the mathematical methods usually employed in the treatment of comparatively elementary portions of physics; and, especially those on the *Hydrokinetic Equations* and on *Waves*, are exceedingly valuable. These appeared in the *Cambridge and Dublin Mathematical Journal*.

Of the higher purely mathematical papers of Stokes we cannot here attempt to give even a meagre sketch. It would be hopeless to attempt to give the general reader an idea of what is meant by the "Critical Values of the Sums of Periodic Series," or even by the "Numerical Calculation of Definite Integrals and Infinite Series;" though we may simply state that under these heads are included some of the most important improvements which pure mathematics have recently received with the view of fitting them for physical applications.

In applied mathematics it is hard to make a selection, so numerous and so important are Stokes' papers. But we may mention specially the following:—

"On the Friction of Fluids in Motion, and the Equilibrium and Motion of Elastic Solids." *Camb. Phil. Trans.*, 1845.

"On the Effects of the Internal Friction of Fluids on the Motion of Pendulums." *Ibid.* 1850.

(In these papers, for the first time, it is shown how to take account of difference of pressure in different directions in the equations of motion of a viscous fluid; the suspension of globules of water in the air as a cloud is for the first time explained and the vesicular theory utterly exploded; and the notion of Navier and Poisson as to a necessary numerical relation between the rigidity and the compressibility of a solid is shown to be untenable. Each one of these is a distinct, and exceedingly great, advance in science; but they are only single gems chosen, as we happen to recollect them, from a rich treasury.)

Then we have a series of magnificent researches on the "Undulatory Theory of Light," for the most part also published in the *Cambridge Philosophical Transactions*. Of these we need mention only three:—

"On the Dynamical Theory of Diffraction." 1849.

(Here, in addition to a splendid experimental inquiry as to the position of the plane of polarisation with reference to the direction of vibration, we have an invaluable inquiry into the properties and relations of Laplace's Operator, an inquiry bearing not alone upon the Undulatory Theory, but also upon gravity, electric and magnetic attractions, and generally upon all forces whose intensity is inversely as the square of the distance.)

"On the Colours of Thick Plates." 1851.

"On the Formation of the Central Spot of Newton's Rings beyond the Critical Angle." 1848.

As another most important contribution to the undulatory theory we have his

"Report on Double Refraction." *British Association Report*, 1862.

Then we have a full investigation, in one respect carried to a third approximation, of the propagation of waves in water; a complete explanation of the extremely rapid subsidence of ripples by fluid friction, &c.

Another paper of great value is—

"On the Variation of Gravity at the Surface of the Earth." *Camb. Phil. Trans.*, 1849.

Perhaps Stokes is popularly best known by his experimental explanation of *Fluorescence*. This is contained in his paper

"On the Change of the Refrangibility of Light." *Phil. Trans.*, 1852.

There can be no doubt, as was well shown by Sir W. Thomson in his Presidential Address to the British Association at Edinburgh in 1871, that Stokes (at least as early as 1852) had fully apprehended the physical basis of *Spectrum Analysis*, and had pointed out *how* it should be applied to the detection of the constituents of the atmospheres of the sun and stars. Since 1852 Thomson has constantly given this as a part of his annual course of Natural Philosophy in the University of Glasgow; but, till 1859, under the impression that it was quite well known to scientific men. Balfour Stewart's experiments and reasoning date from 1858 only, and those of Kirchhoff from 1859.

In some of Stokes' earlier hydrokinetic papers, he for the first time laid down the essential distinction between rotational, and differentially irrotational, motion, which forms the basis of Helmholtz's magnificent investigations about vortex-motion.

Another most valuable paper (a short abstract of which, in the *Reports of the British Association for* 1857, seems to be all that has been published) completely clears up the difficulties which had been felt with regard to the very curious effects of wind upon sound, and the diffraction of waves in air. The singular fact noticed by Sir John Leslie that the intensity of a sound depends, *ceteris paribus*, to a marked extent upon the nature of the gas in which it is produced, is explained in an admirable manner by Stokes in the *Philosophical Transactions* for 1868 in a paper entitled "On the Communication of Vibration from a Vibrating Body to the surrounding Gas."

Of late years Stokes has not published so many papers as formerly: one reason at least has been already hinted to the reader. But there is another. It is quite well known that he has *in retentis* several optical and other papers of the very highest order, but cannot bear to bring them out in an incomplete or hurried form. No doubt he may occasionally hint at their contents in his lectures, but his (undergraduate) audience are likely to take them for well-known and recognised facts [as Thomson unfortunately did in the case of Spectrum Analysis], and so they run the risk of being wholly lost—unless independently discovered. But he has not time to draw them up with the last possible improvements, nor to publish that Treatise on Light and Sound which we all so eagerly expect. Hence the world has to wait while the author devotes his powers to work which a clerk could do nearly as well!

Of these later papers, however, that "On the Long Spectrum of the Electric Light," and particularly those on the "Absorption Spectrum of Blood," are of very great value, the latter especially for their physiological applications.

We must not omit to mention that, partly in conjunction with the late Mr. Vernon Harcourt, Stokes has made a most valuable experimental inquiry into what is called *Irrationality of Dispersion*, chiefly with a view to the further improvement of achromatic telescopes.

He has also proved, by very exact measurements, that the wave-surface for the extraordinary ray in uniaxal crystals is (at least to the degree of accuracy of his experiments) rigorously an ellipsoid of revolution. From the theoretical point of view this is a result of extreme importance; and it is a happy illustration of what we have already said as to the conjunction in Stokes of the experimenter and the mathematician.

Several of his papers are devoted to the extraordinary and, at least at first sight, apparently incongruous properties of the Luminiferous Ether—more especially with the view of explaining (on the Undulatory Theory) the observed Law of the Aberration of Light. He has also reaped an early harvest from the even now promising field of the connection between *Absorption* and quasi-metallic *Reflection* of Light—and has furnished the student with an admirably simple investigation of the *Conduction of Heat in Crystals.*

It is quite possible that, in hurriedly jotting down our impressions and recollections of Stokes' work, we may have omitted something of even greater value than we have recorded. But if so, does the fact not show the absolute necessity that exists for a reprint of all Stokes' works, collected alike from the almost inaccessible *Cambridge Philosophical Transactions*, the ponderous *Philosophical Transactions*, &c., no less than from the *Sitzungsberichte* of the Imperial Academy of Vienna, in which we find Stokes suggesting a preservative for miners against the deadly vapour of mercury?

Stokes was President of the British Association at the Exeter meeting in 1869. The Address he then delivered was a thoroughly excellent and appropriate one; and its modest but firm concluding paragraphs are well calculated to reassure those who may have been perplexed or puzzled by the quasi-scientific materialism of the present day.

P. G. TAIT

SCIENCE EDUCATION FROM BELOW

THE Science Department of the Committee of Council on Education was instituted twenty-two years ago. At that time the general public was far from being alive to its advantages, and for the first seven years it achieved very little. The second term of seven years showed a considerable increase in the number of science schools throughout the country; but it was only during the third septennial period (1867 to 1874) that the importance of such an educational agency became in any sense duly appreciated; and it is not too much to say that it is now one of the most important scientific organisations in this or any country.

Still, in the Government schools as elsewhere, science teaching hitherto has had uphill work, nor must we delude ourselves with the pleasing idea that the road is now all smooth and level. It is true that for some years past the extension of education in this direction has been a popular cry, and a good deal of political capital has been made of it. The international exhibitions have been mainly at the bottom of this; and one of the great benefits derived from those occasions of friendly rivalry has been the diminution of that self-satisfaction which is the greatest bar to progress. Economists have reminded us that we have been relying upon our physical advantages as a nation, rather than the intelligence of our people, in our competition with the rest of the world, and that if we are to maintain our supremacy we must not be behind other nations in the practical applications of knowledge. The argument goes home readily enough to a commercial people, but it is one thing to admit the fact, and another to apply the remedy. The majority of the upper class, from the circumstances of their position and education, are indifferent to the matter. It is foreign to the idea of our older Universities and public schools; and these have exercised, and still continue to exercise, a direct influence over the middle-class schools. True, the number of professional chairs is on the increase, and opportunities are now afforded of practical study in physical and chemical laboratories; but it cannot be pretended that these studies yet take their proper rank amongst the rest. The inferior educational establishments naturally take their cue from the superior ones; indeed, they do so almost as a matter of necessity. They have not only to please the public, but the masters can only impart to their scholars the knowledge they themselves possess; and until on the one hand it be required that the pupils should be taught science, and on the other the masters find it to be an indispensable portion of their educational course, the progress of these studies in private schools will be but slow. In our large towns special teachers can be had for the purpose, but as a fact they are discouraged, the subjects they teach being generally regarded as extras and reduced to a minimum so as not to interfere with the regular routine of the school and the work of the resident masters. So long as the time of the boys is to be wasted in making wretched Latin verses, and the amount of their learning is to be measured by the retentiveness of their memory rather than by how much they understand, the hope of progress in this quarter must inevitably be small.

The operations of the Government department have, however, no direct bearing upon any such schools, unless the principals choose to avail themselves of it as an examining body; but we believe the indirect influence to be already considerable, and likely to become more so in the course of the next few years. Nothing will tend to arouse the proprietors of our boarding schools throughout the land to the necessity of improving both the quantity and quality of the instruction given in them, more than the upward pressure that will be exerted by those who in a social sense occupy the level immediately below them. The moving impulse is from below, and to that we must now more particularly direct our attention.

From the first the South Kensington establishment has acted as an examining body, and the staff appointed for that purpose includes the names of the most eminent professors in natural and physical science. Subject to certain limitations the passes carry with them pecuniary grants to the authorised local teachers; prizes and medals of honour to the most proficient of the students. The department also makes grants in aid of scholarships and the Royal and local exhibitions, as well as having the administration of those scholarships which were endowed by Sir Joseph Whitworth. Grants are also made in aid of new local schools of science, and towards the cost of the apparatus which they may require. Special classes for the improvement of acting teachers are held by some of the Professors. Lastly, we must not omit to mention in our summary the well-known museum under its management, and the too little known educational library which is available to the general public on payment of a very trifling fee.

The twenty-three branches of study dealt with include Mathematics, Mechanics, Physics, Natural Science, and some of the Applied Sciences. The six most popular among the students are Physical Geography; Pure Mathematics; Animal Physiology; Magnetism and Electricity; Inorganic Chemistry; Acoustics, Light, and Heat: some, such as Navigation and Nautical Astronomy, are, from their very nature, little studied except in special localities. The large preponderance of students in Physical Geography, generally nearly double that of the next in rank, is due to girls' schools, in which it forms a leading feature, being included.

Those who care for statistics will be interested in the following table, for which we are indebted to the courtesy of the Secretary of the Science and Art Department. The table shows the actual state of the Science Classes in Great Britain during the last session.

—	I.—Practical Plane and Solid Geometry.	II.—Machine Construction and Drawing.	III.—Building Construction.	IV.—Naval Architecture.	V.—Mathematics. Stages 1, 2, 3.	V.—Mathematics. Stages 4, 5.	V.—Mathematics. Stages 6, 7.	VI.—Theoretical Mechanics.	VII.—Applied Mechanics.	VIII.—Acoustics, Light, and Heat.	IX.—Magnetism and Electricity.	X.—Inorganic Chemistry.	XI.—Organic Chemistry.	XII.—Geology.	XIII.—Mineralogy.	XIV.—Animal Physiology.	XV.—Elementary Botany.	XVI. and XVII.—General Biology.	XVIII.—Principles of Mining.	XIX.—Metallurgy.	XX.—Navigation.	XXI.—Nautical Astronomy.	XXII.—Steam.	XXIII.—Physical Geography.
No. of Classes.	211	248	181	12	537	18	5	105	66	357	485	322	49	162	15	414	66	35	6	10	32	9	73	686
No. of Students.	4631	5201	2518	183	10502	251	23	2265	1238	8463	12515	8259	701	3183	307	9470	1914	547	110	110	537	236	1260	17720
Students examined.	2500	3968	1302	117	6228	121	21	1668	704	5473	9122	5264	286	2598	116	6623	1168	209	95	173	251	92	908	13312

The students for whom this machinery is designed belong to what may be termed the Industrial Classes, including all those in receipt of weekly wages, small tradesmen whose income does not exceed 200*l*. per annum, the children of any of these, all attendants at Public Elementary Schools, together with the teachers and pupil teachers of such, and the students in the Training Colleges which receive grants from the Education Department. This list of course includes such as constitute our mechanics' institutes and co-operative societies, in the programmes of which science classes now form an important element. In these the practical advantages are of a most direct character; but we are disposed to ascribe a still higher value to the assistance rendered in the Training Colleges and to the acting and pupil teachers in the Public Elementary Schools. Hitherto one of the difficulties which the department has had to contend against has arisen from the unavoidable circumstance that so many of the local science teachers are themselves self-taught, and their deficiencies have often been only too apparent in the character of the examination papers given in by their pupils: time, however, will do much to cure this as these teachers drop into the background and are succeeded by those who have gone through a systematic training.

The next table will show the rapid extension of the operations of the department during the years 1867 to 1873 inclusive. It will be seen, on comparing the figures, that the relative number of those who now go up for examination is greater than formerly, and that the increase in the number of papers worked is still greater in proportion.

Year.	Number of Science Scholars.	Number who went up for Examination.	Number of Examination Papers worked by them.	Number of Papers passed.
1867	10,230	4,520	8,213	6,013
1868	15,010	7,092	13,112	8,649
1869	24,865	13,234	24,085	14,550
1870	34,283	16,515	34,413	18,690
1871	38,015	18,750	38,098	22,105
1872	36,783	19,568	39,383	27,806
1873	48,546	24,674	56,577	35,100

It is abundantly clear then that through the enlightened and vigorous action of the Science and Art Department, a large bulk of the population of our country has received and is receiving an elementary scientific education. The work which Sir Henry Cole began can no longer be sneered at nor overlooked; its value to this country is beginning to be widely recognised, and the man who laid its foundations so wisely and well deserves the highest gratitude of his countrymen. Let us remember that only a few years ago there was little science education in the higher classes, and absolutely none in the lower; whereas, scattered over Great Britain, there are in active work this year no less than 1,707 certificated science teachers engaged in 1,374 science schools, teaching 4,104 separate classes, and the number of individuals actually receiving science instruction by this means reaches the enormous total of 48,274.

The Department, however, has not been content to rest on its laurels. Within the last few years it has undertaken a new work, which promises to be of the highest value. It was felt that the system of examinations needed supplementing. Teachers could gain certificates, and thus receive payment upon the results of their teaching, without any evidence of their having more than book knowledge. And it was found, indeed, that the great body of certificated teachers had, with few exceptions, little practical knowledge of the various subjects they taught. They could accurately describe an electrophorus, but they could not make one, nor use it perhaps when made; they knew all about the circulation of the blood or the structure of the heart, but they had never seen the one nor dissected the other. For the most part they knew nature as words, not as living facts. The eminent men who conduct the examinations for the Department saw the danger that was arising. Prof. Huxley addressed the Government upon the subject, and urged a practical class in Physiology for a certain number of science teachers certificated in that subject. By taking fresh men each year it was hoped that a large amount of practical knowledge would be diffused and gradually make its way through the various science classes. The late Government promptly acceded to the wish thus expressed, and in 1869 two short practical courses of a week each were given, the one on Animal Physiology and the other on Light.

The importance of even such brief instruction was so manifest that it was decided to enlarge the original conception. The details of the scheme were, however, difficult and needed to be grappled with in earnest. The body of teachers was large and distributed over wide areas; they could not afford the time nor money to come to London for instruction, and even if they had the requisite knowledge their means were too slender to enable them to purchase the apparatus needed for the proper demonstration of their subject. To the administrative genius of Major Donelly, the present chief of the Science Staff at South Kensington, no less than to his untiring zeal in the cause of scientific education, the country is mainly indebted for the solution of this formidable difficulty. Announcements were made to all the certificated science teachers throughout the country that a month or six weeks' gratuitous course of daily practical instruction, in various branches of experimental science, would be held at the new Science Schools at South Kensington during the summer vacation. Those who wished for this instruction were to apply to the Department; if selected, their expenses to and from London would be paid, and thirty shillings a week given to each as a maintenance allowance whilst they remained in London. It was soon found impossssible to accommodate all who applied; at present the applications are about three times as many as can be taken. In the selection of the men most needing this kind of instruction, and who would afterwards make the best use of it, arose another difficulty. But, as before, the excellent judgment of the Secretary of the Science and Art Department, and the careful scrutiny of his officers, led to a choice of such capital men that the wisdom of their mode of selection has been shown in the happiest manner.

At the present moment sixty teachers are working at Practical Chemistry under Prof. Frankland and Mr. Valentin; thirty-one teachers are studying Heat practically under Prof. Guthrie; these have been preceded by the same number who have worked at Light; twenty-one are studying Mechanics with Professors Goodeve and Shelley; twenty-eight are being taught Geometrical Drawing by Prof. Bradley; and thirty-eight are working at Machine Construction and Drawing under Prof. Unwin.

The applicants give a list of the courses they wish to attend, in much the same way that one hands in a selected list of books to Mudie's Library; they are allotted courses as far as possible in their order of preference, and may, in successive years, take successive subjects. The courses only last from three to six weeks. Chemistry this year runs on from the 1st to the 23rd of July; Physics, from June 23rdto Aug. 3rd; Mechanics and Geometrical Drawing from June 30th to July 22nd; and Machine Construction from 27th July to13th of August. It might be imagined that such short courses could be of little real use; experience has, however, shown the reverse. The fact is, the men in each subject are thirsting for information, they know they have now a chance which may never recur to them; in a few short weeks they must strive to win much knowledge, which they not only desire for its own sake, but which means bread and cheese to their families. They are prompted, therefore, by every inducement to make the best possible use of their time. It is this heartiness of work combined with the admirable system of instruction given by each professor that has made these short summer courses so remarkably effective.

Capital evidence of the value of what is being done may be had by simply walking through the different rooms of the Science Schools and observing the teachers at work. If, for example, we go into the Biological department,* we find every man busily dissecting plants or animals, each one seated at a separate little table, and each provided with an excellent microscope and proper instruments and suitable specimens. The earnestness of everybody in the room strikes one very forcibly; and as we look at the fresh specimens at every table, we think of the labour implied in choosing typical objects and securing forty or fifty of each daily. Professors and students unquestionably are hard at work. If we now go into the fine chemical laboratories a like impression is produced. Here are one set making perhaps their first practical acquaintance with the reactions which they have so often written down, and which in future they will regard with an altogether new interest and delight. Others more advanced are conducting analyses, or perhaps making "combustions"—if in the advanced group, studying organic chemistry. All are intensely busy, and work with a fixed purpose before them. The same quiet activity is noticeable in the different subjects going on in the other rooms. Entering last the physical laboratory on the ground floor, we find the teachers constructing apparatus which, though simple and often rough, is well adapted for teaching purposes. The raw material is provided them, printed instructions are given to each one, and under the direction of Prof. Guthrie, and the gentlemen associated with him, the most useful physical instruments are built up. These instruments are then employed in repeating the experiments seen in the morning lecture, or in making physical measurements wherever it is possible to do so. The homely apparatus, it is true, has not the polish of the instrument-maker, but in delicacy and efficiency is, generally speaking, far better than the teachers could purchase out of the small grants allowed to them for that purpose. With a wise liberality the Department permits each teacher to take home with him, without any charge, all the apparatus he himself has made: and one can easily imagine the pleasure with which these simple and useful instruments are afterwards looked upon and used by those who have made them. Nor is this all; the impulse to sound and practical science teaching is given, and at the same time the hands have been disciplined to useful skill, and the senses trained to accurate observation. After such preparation good use is made by the teachers of the more refined physical instruments which are set before them, but which are beyond their time or power to construct for themselves. It is most instructive to watch one of these men as he makes his first essay, and to trace the growth of his education in manipulative skill and in practical knowledge of his subject. We propose in our next number to go more fully into detail in this matter, and to describe some of the simple physical apparatus made by the teachers.

But the good work done by the Department does not rest here. In addition to giving practical instruction to teachers in short summer courses, free admission to extended courses of lectures and practical instruction in Chemistry, Physics, Mechanics, and Biology at South Kensington was granted to a limited number of teachers and students who intended to become science teachers. The selected candidates received a travelling allowance, and a maintenance allowance of 25*s*. a week while in London. The courses in Chemistry and Biology commenced in October of last year and ended in the early spring, when the courses in Physics and Mechanics began, and these closed at the beginning of this summer. From ten to sixteen teachers in training attended these different classes, and worked daily from 10 to 5 at the subjects they had chosen, in the evening writing up their notes and memoranda. Botany was not included in the foregoing series, but it was not forgotten. In January last the Lords of the Committee of Council on Education gave directions for a practical course on this subject. The course was given by Prof. Thiselton Dyer, and commenced on the 4th of March last, extending over eight weeks. It was attended by twenty-three science teachers and persons intending to become science teachers; these received precisely the same advantages as the teachers in training in the other subjects.

The value of such courses as these can hardly be overestimated, and we trust that no niggardly policy will lead the Government to restrict the great and good work they have begun. We hope there is no cause for apprehension in the apparent neglect of Biology in the summer course given this year, and what seems to us a little diminution of the strength of the staff in another subject. The improvement in the quality of the education given by the science teachers is already making itself felt. The reports of the May examiners for recent years show that "while the general average has been maintained throughout, the instruction had in some subjects decidedly improved." But it will necessarily take a few years to lift up so large a constituency. Surely and slowly it is being done, and the masses of the country are gaining a sound elementary knowledge of science. Whilst the magnificent laboratories of the Universities of Oxford and Cambridge and Dublin are nearly empty, Owens College and the classes under the Department are crowded with active and earnest workers.

The several large educational societies of England have availed themselves for some years past of the benefits offered by the Science and Art Department, with the object of turning the students out of their Training Colleges as thoroughly fitted as possible for their future scholastic career; and the continuance of this system for the future is now further assured by the necessity of their being provided with Government certificates in science in order to secure employment under the London School Board, or indeed at any of the first-class Elementary Schools throughout the country.

An impartial view of the facts we have placed before our readers will show that what the Universities might have done from above, others are doing from beneath. Science, instead of forming the delightful pursuit of the leisure classes, and thence distilling downwards to the workers, is, on the contrary, first becoming an integral part of the education of the toilers of the country. England, in fact, is being scientifically educated from below.

DARWIN ON CARNIVOROUS PLANTS

I.

Insectivorous Plants. By Charles Darwin, M.A., F.R.S., &c. With Illustrations. (London: J. Murray, 1875.)

TO have predicted, after the publication of Mr. Darwin's works on the Fertilisation of Orchids and the Movements and Habits of Climbing Plants, that the same writer would hereafter produce a still more valuable contribution to botanical literature, characterised to an even greater extent by laborious industry and critical powers of observation, and solving or suggesting yet more important physiological problems, would have seemed the height of rashness. And yet, had such a prediction been made, it would have been amply justified by the present volume, one which would alone have established the reputation of any other author, and which will go far to redeem our country from the charge of sterility in physiological work. Much attention has been called recently to the singular subject of "carnivorous plants;" we have had records of useful original work from several quarters in England, the Continent, and America, together with much that has been superficial and worthless; and even the newspapers have discussed the anti-vegetarian habits of some vegetables in the light, airy, and philistine manner in which they are wont to approach "mere scientific" subjects. During the whole of this time, for the last fifteen years, Mr. Darwin has been steadily and quietly at work, collecting materials and recording long series of observations; and now at length has given us their results, completely and finally settling some of the points that have been most in controversy, and raising others which suggest conclusions that will take by surprise even those whose minds have been most open to deviate from the old and narrow paths.

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* This refers to last year; the teachers' summer course on Biology has been omitted this session.

Rather more than one-half of the volume is devoted to the most abundant and readily obtainable of these predatory plants, the common Sundew, *Drosera rotundifolia;* and an epitome of this portion must be first placed before our readers.

Commencing with a description of the well-known leaves and their glandular appendages, or "tentacles," as he terms them, Mr. Darwin has arrived at the conclusion that these latter most probably existed primordially as glandular hairs or mere epidermal formations (trichomes), and that their upper part should still be so considered; but that their lower portion, which alone is capable of movement, consists of a prolongation of the leaf; the spiral vessels being extended from this to the uppermost part. One point which seems to be clearly established is, that it is not sufficient that the substance which excites the movements of the tentacles should merely rest on the viscid fluid excreted from the glands; it must be in actual contact with the gland itself. A statement made by several previous observers (including Prof. Asa Gray on the authority of Mr. Darwin's earlier observations, and the present writer)—that inorganic substances are almost or entirely without effect in producing movement—must now be modified. Although the effect is much less considerable, and the substance is soon released from the embrace of the tentacles; yet such bodies as minute particles of glass undoubtedly possess the power of irritation. While it is the glands or knobs at the extremities of the tentacles, and a very small part of the upper portion of the pedicels, which alone are sensitive or irritable, the actual inflection takes place only in the lowermost portion of the pedicel, causing a bending of the tentacle; and the irritation is conducted from the tentacle actually excited to the neighbouring ones, or to all those on the leaf, in such a manner as to cause them to bend towards the object which produces the excitement. One of the most striking of the series of observations here recorded is that which describes the affixing of exciting particles on glands at two different portions of a leaf of *Drosera*, the result being that all the tentacles near each of these two points were directed towards them, "so that two wheels were formed on the disc of the same leaf, the pedicels of the tentacles forming the spokes, and the glands united in a mass" over the irritated tentacle which represented the axle; the precision with which each tentacle pointed to the irritating particle was wonderful. What makes this result the more extraordinary is that "some of the tentacles on the disc, which would have been directed to the centre had the leaf been immersed in an exciting fluid (as in Fig. 1), were now inflected in an exactly opposite direction, viz., towards the circumference. These tentacles, therefore, had deviated as much as 180° from the direction which they would have assumed if their own glands had been stimulated, and which may be considered as the normal one." As the author remarks, "we might imagine that we were looking at a lowly organised animal seizing prey with its arms." Indeed, the whole description of Mr. Darwin's researches after the tissue that conducts this irritation reminds one of experiments on the motor and sensitive nerves of animals; and we commend the subject to the serious attention of the Royal Commission now sitting to investigate the subject of vivisection. Mr. Darwin compares this movement to the curvature displayed by many tendrils towards the side which is touched; but the comparison appears to us to fail, from the fact that the movement of tendrils is a function of growth, they being sensitive to contact or pressure only so long as they are in a growing state; which is not the case with the tentacles of *Drosera*. One of the most extraordinary of the statements made by trustworthy observers with regard to the sensitiveness of these tentacles is not, however, confirmed by Mr. Darwin. Mrs. Treat (*American Naturalist*, Dec. 1873) asserts that when a living fly was pinned at a distance of half an inch from the leaves of the American species *D. filiformis*, the leaves bent towards it and reached it in an hour and twenty minutes, a phenomenon inexplicable on any theory which would account for the transmission of the irritation from one tentacle to another. Mr. Darwin states, on the contrary, that when pieces of raw meat were stuck on needles and fixed as close as possible to the leaves, but without actual contact, no effect whatever was produced. The minuteness of the solid particles which produced sensible inflection was a matter of great surprise. Particles perfectly inappreciable by the most sensitive parts of the human body, as the tip of the tongue—a fragment of cotton weighing $\frac{1}{8000}$, and of hair weighing $\frac{1}{78000}$ of a grain—caused the tentacles with which they were in contact to bend. Our author remarks that "it is extremely doubtful whether any nerve in the human body, even if in an inflamed condition, would be in any way affected by such a particle supported in a dense fluid, and slowly brought into contact with the nerve; yet the cells of the glands of *Drosera* are thus excited to transmit a motor impulse to a distant point, inducing movement;" and he adds justly, that "hardly any more remarkable fact than this has been observed in the vegetable kingdom." The only substance which appears to be altogether without effect in producing inflection is drops of rain-water; a singular exception paralleled by the case of certain climbing plants whose excessively sensitive tendrils are irritable to every sort of object which touches them except rain-drops.

The inflection of the base of the tentacle is accompanied by a change in the molecular condition of the protoplasmic contents of the cells of the gland and of those lying immediately beneath it; though the two phenomena are not necessarily connected with one another. If the tentacles of a young but mature leaf that has never been excited or become inflected, are examined, the cells forming the pedicels are seen to be filled with a homogeneous purple fluid, the walls being lined with a layer of colourless circulating protoplasm. If a tentacle is examined some hours after the gland has been excited by repeated touches, or by an inorganic or organic particle placed on it, or by the absorption of certain fluids, the purple matter is found to be aggregated into masses of various shapes suspended in a nearly or quite colourless fluid. This change commences within the glands, and travels gradually down the tentacles; and the aggregated masses of coloured protoplasm are perpetually changing their form, separating, and again uniting. Shortly after the tentacles have re-expanded in consequence of the removal of the exciting substance, these little coloured masses of protoplasm are all re-dissolved, and the purple fluid within the cells becomes as homogeneous and transparent as it was at first. This process of aggregation is independent of the inflection of the tentacles and of increased secretion from the glands; it commences within the glands, and is transmitted from cell to cell down the whole length of the tentacles, being arrested for a short time at each transverse cell-wall. The most remarkable part of the phenomenon is that even in those tentacles which are inflected, not by the direct irritation of their glands, but by an irritation conducted from other glands on the leaf, this aggregation of the protoplasm still commences in the cells of the gland itself.

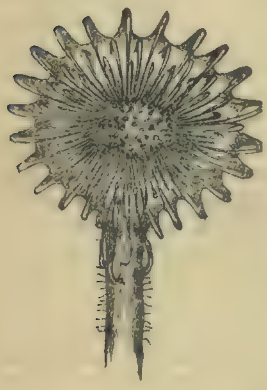

FIG. 1.—(*Drosera rotundifolia.*) Leaf (enlarged) with all the tentacles closely inflected, from immersion in a solution of phosphate of ammonia (one part to 87,500 of water).

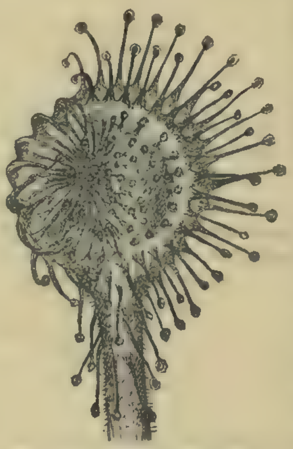

FIG. 2. — (*Drosera rotundifolia.*) Leaf (enlarged) with the tentacles on one side inflected over a bit of meat placed on the disc.

Some who admit the reality of the phenomena now described, have still doubted the digestive power ascribed to the leaves of the Sundew, believing that the apparent absorption of the organic substances in contact with the glands is due rather to their natural decay. This question is, however, entirely set at rest by Mr. Darwin's observations. The action of the secretion from the glands on all albuminous substances—for it is by these only among fluids that inflection of the tentacles is excited—is precisely the same as that of the gastric juice of animals. The secretion of the unexcited glands is neutral to test-papers; after irritation for a sufficiently long period it is distinctly acid. A very careful analysis by Prof. Frankland of the acid thus produced indicated that it was probably propionic, possibly mixed with acetic and butyric acids; and the fluid, when acidified by sulphuric acid, emitted a powerful odour similar to that of pepsin. If an alkali is added to the fluid, the process of digestion is stopped, but immediately recommences as soon as the alkali is neutralised by weak hydrochloric acid. Mr. Darwin believes that a ferment of a nature resembling that of pepsin is secreted by the glands, but not until they are excited by the absorption of a minute quantity of already soluble animal matter; a conclusion which is confirmed by the remarkable fact observed by Dr. Hooker, that the fluid secreted by the pitchers of *Nepenthes* entirely loses its power of digestion when removed from the pitcher in which it is produced. It is one of the many extraordinary facts connected with this subject that the tentacles of the leaves of *Drosera* retain their power of inflection and digestion long after the separation of the leaves from their parent plant.

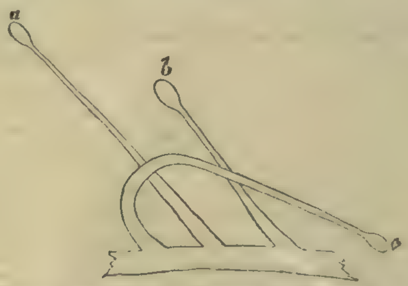

FIG. 3.—(*Drosera rotundifolia.*) Diagram showing one of the exterior tentacles closely inflected; the two adjoining ones in their ordinary position.

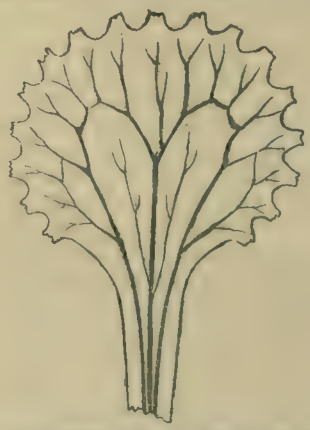

FIG. 4.—(*Drosera rotundifolia.*) Diagram showing the distribution of the vascular tissue in a small leaf.

As might naturally be expected, salts of ammonia are among the substances which have the most powerful effect on the leaves of *Drosera*; but the excessively minute quantities which are efficacious will probably be as astonishing to everyone else as they were to Mr. Darwin himself. From a most carefully conducted series of experiments from which every possible source of error seems to have been eliminated, it appears that the absorption by a gland of $\frac{1}{268800}$ of a grain of carbonate of ammonia (this salt producing no effect when absorbed through the root) is sufficient to excite inflection and aggregation of the protoplasm. With nitrate of ammonia a similar effect is produced by the $\frac{1}{691200}$ of a grain; while the incredibly small quantity of $\frac{1}{19760000}$ of a grain of phosphate of ammonia produces a like effect. Mr. Darwin believes that carbonate of ammonia is also absorbed in the gaseous state by the tentacles; but we venture to think that the evidence on this point is not conclusive. In both the experiments which he records the air surrounding the plant was more or less humid, and the effect was much more intense in the one where the air was the dampest, indicating apparently that the inflection was due to the absorption of the extremely soluble gas by the moisture which was in contact with the tentacles. This would also afford an explanation of what he regards as "a curious fact, that some of the closely adjoining tentacles on the same leaf were much, and some apparently not in the least, affected," if we suppose that they were clothed with larger and smaller amounts of moisture. The view that the glands have no power of absorbing gases or effluvia receives confirmation from the failure of the attempt to induce inflection or aggregation by the affixing of particles of meat in close proximity to the tentacles, but without actual contact.

We cannot follow Mr. Darwin through his exhaustive series of experiments on the effects of various solutions of mineral salts, acids, and poisons, on the leaves of *Drosera*. With organic fluids the aggregation of the protoplasm and inflection of the tentacles furnish a most delicate and unerring test of the presence of nitrogen. The effect of inorganic salts and poisons can by no means be inferred from the effect of the same substances on living animals, nor from their chemical affinity. Nine salts of sodium all produced inflection, and were not poisonous except when given in large doses; while seven of the corresponding salts of potassium did not cause inflection, and some of these were poisonous. This corresponds to the statement of Dr. Burdon Sanderson, that sodium salts may be introduced in large quantities into the circulation of mammals without any injurious effects, whilst small doses of potassium salts cause death by suddenly arresting the movements of the heart. Benzoic acid, even when so weak as to be scarcely acid to the taste, acts with great rapidity and is highly poisonous to *Drosera*, although it is without marked effect on the animal economy. The poison of the cobra, on the other hand, so deadly to all animals, is not at all poisonous to *Drosera*, although it causes strong and rapid inflection of the tentacles, and soon discharges all colour from the glands.

The last point of investigation is the mode of transmission and nature of the conducting tissue of the motor impulse from one tentacle to another. It has been already stated that the seat of irritability is limited to the glands themselves and a few of the uppermost cells of the pedicels, the blade of the leaf itself not being sensitive to any stimulant. In order to be conveyed from one tentacle to another, the impulse has therefore to be transmitted down nearly the whole length of the pedicel; and it appears to be conveyed from any single gland or small group of glands through the blade to the other tentacles more readily and effectually in a longitudinal than in a transverse direction. It can be shown that impulses proceeding from a number of glands strengthen one another, spread further, and act on a larger number of tentacles than the impulse from any single gland. The phenomenon already alluded to, of the aggregation of the protoplasm in a tentacle incited indirectly by the irritation of other glands on the leaf—this aggregation advancing not upwards, but downwards, in each tentacle—is spoken of by Mr. Darwin as partaking of the nature of those actions which in the nervous systems of animals are called reflex. The existence of such a phenomenon—of which this is the only known instance in the vegetable kingdom—is one of the most extraordinary points brought out by these investigations. It will be recollected that the transmission of the motor impulse in the sensitive leaves of *Mimosa* is in a precisely opposite direction, travelling upwards from the base to the apex of those pinnæ which are indirectly irritated in consequence of the direct irritation of other pinnæ of the same leaf. The arrangement and direction of the fibro-vascular bundles in the leaves of *Drosera* are shown in Fig. 4; and Mr. Darwin's inquiries were first directed to solve the question whether the impulse was conveyed through the vascular system; but he came to the conclusion that it is not sent, at least exclusively, through the spiral vessels or through the tissue immediately surrounding them. He believes, on the contrary, that the conducting tissue is the parenchyma or cellular tissue of the mesophyll of the leaf; and that it is chiefly delayed by the obstruction offered by the cell-walls through which it has to pass; the transmission of the impulse being indicated by the phenomenon of aggregation of the protoplasm, which is transmitted gradually from cell to cell.

A few other species of *Drosera* were examined, but presented no special phenomena of interest; and the remainder of the volume is occupied by the narrative of researches on other carnivorous plants, a review of which we must defer to a future number.

ALFRED W. BENNETT

(*To be continued.*)

PERCY'S METALLURGY

Metallurgy: Introduction, Refractory Materials and Fuel. By John Percy, M.D., F.R.S. (London: J. Murray, 1875).

THIS valuable work is not merely a new edition of the volume previously published by its distinguished author, for it contains more than 350 pages of fresh matter, and several articles on subjects which were not treated of originally. Dr. Percy's "Metallurgy" is so well known as the standard book in this country that it may be well to indicate as succinctly as possible the differences between the present volume and the portion of the one published in 1861, which was devoted to refractory materials and fuel.

Much information has been added to the section which treats of the physical properties of metals. Thus a general but comprehensive view of the subject of Elasticity is given, with ample references to the works of Wertheim, Kupffer, Styffe, and others. Tresca's experiments on the flow of metals are also briefly described, and "Tensile strength" has received due attention. Graham's experiments on the occlusion of gases by metals are described at some length.

The matter relating to the composition, fusibility, and character of slags, has been re-arranged.

As plumbago crucibles are now so extensively used, the question of the suitability of different kinds of graphite for their manufacture has become of much importance. A valuable table of analyses of graphite of various qualities from different localities is therefore given, and the machinery used by Messrs. Morgan in their well-known crucible works is illustrated by excellent drawings. The apparatus devised by Ste. Claire Deville for obtaining high temperatures is now frequently employed in laboratories, and the description of the methods of making the crucibles of carbon, lime, magnesia, alumina, and bauxite will be of much service. Deville's blast furnace is described, but we could have wished that, in the interests of metallurgical research, some account had been given in this place of the oxyhydrogen blowpipe, and of the apparatus by means of which he melted platinum.

Care has been taken to collect the recently discovered facts relative to the calorific power and calorific intensity of fuel, and these are specially considered with reference to furnace temperatures. The section devoted to Pyrometry is excellent, and Weinholt's classification of the principles on which the instruments have been constructed has been adopted.

The question of the utilisation of peat and of the possibility of substituting it for coal in metallurgical and other manufacturing processes, has of late particularly engaged public attention in this country. Dr. Percy has therefore collected "such evidence as may enable the reader to arrive at a satisfactory judgment on that question," and forty-six pages are devoted to the consideration of cutting peat, together with its mechanical treatment, condensation, and desiccation. We may quote some of Dr. Percy's general conclusions as to its use as fuel. He observes that, "so far as the suitability of peat for metallurgical purposes is concerned, we may not unreasonably conclude that it could be widely substituted for coal with success;" but he states as his conviction that peat can only compete with coal in countries where the cost of production and carriage of peat is relatively very low and the price of coal is relatively very high.

More than 200 analyses of coal from various parts of the world are given, and we may mention as an indication of the care which has been taken to render the section devoted to coal as complete as possible, that Von Meyer's recent investigations as to the nature of the gases disengaged from certain varieties, and Fleck's table showing the action of weathering on the chemical composition of coal, are recorded at some length. Valuable remarks as to the various sources of error in the analysis of coal are given, but we venture to think that students would have been grateful for some account of the methods of analysis and details of manipulation.

The author next treats of charcoal, and an account of Dromart's process for charring in circular piles by firing at the bottom has been added to the descriptions of the various processes contained in the former volume. Reference is also made to the methods of preparing brown charcoal and "torrefied wood," and the section concludes with theoretical considerations concerning their use.

In the new matter relative to coke, the various methods of desulphurisation are treated at some length, and, in considering the economic products generated during coking, Dr. Percy gives much evidence as to the working of Pernolet's oven; but he concludes, as in the case of many other metallurgical operations, by pointing out that the evidence as to the advantages of the process "is not a little conflicting." A new article has been added on the preparation of peat-charcoal, with reference to the employment of which the author observes "that as yet the use of peat-charcoal in metallurgical operations in Great Britain is either very restricted or must be kept rigidly secret."

The consideration of one or two questions of practical importance in connection with the subject of fuel is reserved for the conclusion of the volume.

The author, in treating of the preparation of peat for fuel, makes some observations on patents generally which deserve notice. He says: "Should any person of ordinary intelligence be disposed to wade through the dreary specifications of patents relating to the preparation of peat for fuel, he will perceive that frequently the same thing has been patented several times, and that in not a few cases the patentees have displayed astounding ignorance of the subject." He suggests as a remedy that "a tribunal for the administration of patent law" should be established. "The expenses of such a tribunal could be defrayed . . . . out of the large *surplus* income, exceeding 50,000*l.*, arising from the duties and fees paid by patentees." The authority of such a court would doubtless have a very beneficial effect; but we may point out that the sum above named would probably be very materially reduced by its intervention, and that the vigilance and remuneration of the tribunal might each tend to diminish the other. Dr. Percy calls attention to the scheme proposed during the present session by the Lord Chancellor, who suggests the appointment of five additional commissioners of patents, without giving them any remuneration whatever for their services!

Among the illustrations are plans and sections of Ekman's peat kiln, of Échement's pile for making brown charcoal, and at the end of the volume there are nine folding plates, some of them coloured, giving complete working drawings of Siemens' gas producer and regenerative gas reheating furnace, and of Coppée's coke oven, in which even the forms and dimensions of the fire-bricks are shown. The drawings throughout the volume are admirable, and, as is the case in all Dr. Percy's works, are drawn to scale.

We think that it is a matter for congratulation that the author's labours have been devoted to rendering the introduction to Metallurgy as complete as possible, before considering metals not yet touched upon, which would doubtless have been more attractive work. Throughout this, as in former volumes, the slightest aid has been carefully acknowledged, and the relative merits of discoverers are most conscientiously apportioned, in Dr.

Percy's remarks, which are sometimes severe but always impartial.

In viewing the volume in relation to metallurgical science generally, we are reminded of a remark made by Dumas more than twenty years ago: "Les nouvelles substances métalliques ne méritent certes pas l'oubli dans lequel les chimistes les laissent depuis si longtemps." We fear that the words apply with some force to the state of metallurgical *research* at the present day; still, the progress which has been made is very considerable, and this country has good reason to be proud of Dr. Percy's contributions to the literature of the subject.

OUR BOOK SHELF

Sound. By John Tyndall, D.C.L., LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution of Great Britain. Third Edition. (London: Longman and Co., 1875.)

THE principal addition to this new edition of Dr. Tyndall's work on Sound is an account of the investigation which he has conducted in connection with the Trinity House, and which he treats here under the title, "Researches on the Acoustic Transparency of the Atmosphere, in relation to the question of Fog-signalling." By this investigation, "not only have the practical objects of the inquiry been secured, but a crowd of scientific errors, which for more than a century and a half have surrounded this subject, have been removed, their place being now taken by the sure and certain truth of nature." In his preface Dr. Tyndall remarks on some of the criticisms which have been made on the results of the investigations referred to. It is interesting to learn that the work has been translated into Chinese, and published at the expense of the Government at the moderate price of 20*d.*

Six Lectures on Light, delivered in America in 1872-73. By John Tyndall, D.C.L., F.R.S., &c. Second Edition. (London: Longman and Co., 1875.)

WE are glad to see that these interesting popular lectures, to which we referred during and after their delivery, have reached a second edition; they are well calculated to interest the general reader, and, we have no doubt, have been the means of inducing many to make a systematic study of the subject to which they refer. The principal change in this edition is the omission of Dr. Young's "Reply to the Edinburgh Reviewers," the reprint of which in the first edition, Dr. Tyndall believes, has served the purpose intended. In place of this, a beautifully executed steel engraving of Lawrence's portrait of Young is prefixed to the volume.

The Birds and Seasons of New England. By Wilson Flagg. With Illustrations. (Boston; Osgood and Co. London: Trübner and Co., 1875).

MR. FLAGG is evidently an enthusiastic lover and close observer of nature in all her moods and phases, but this more from the sentimental and poetic than from the scientific point of view. His book consists of a great number of essays on various aspects of nature as manifested in the New England country, the most original being on the songs of the birds of that region. That he must be a very patient and very minute observer is evidenced by the fact that he has actually embodied in musical notation the songs of some of the principal singing birds of New England. We have no means of testing the correctness of Mr. Flagg's interpretation of these singers, but we should think, judging from the very careful observations he has evidently made, that they are generally correct. The work also contains essays on the aspects of nature in the various months of the year, and on such subjects as "The Haunts of Flowers," "Water Scenery," "The Field and the Garden," "Picturesque Animals," "The Flowerless Plants," "Swallows: their Hibernation," "Changes in the Habits of Birds," &c. Mr. Flagg's essays, we must say, are on the whole rather tedious, reminding us often of the tiresome moral essayists of last century, although they frequently contain passages of quite poetic beauty. There is also a sufficient amount of novelty about many of the subjects to add interest to his observations, and many facts are recorded concerning the habits of the New England birds that will give the book some value in the eyes of the naturalist. Those who love a quiet dreamy country life will find much throughout the book to interest them. Mr. Flagg, as we have said, evidently possesses the power of minute observation, and we would recommend him to bring himself abreast of the ornithology, and indeed general natural history, of the day, and carry on his observations from a more scientific point of view, which he can easily do, and still find scope enough for the satisfaction of his sentimentalism; he might thus render substantial service to science. Judging from what he says about the "hibernation" of swallows, he seems to be unaware that anything has been written on the subject of the migration of birds since the days of Gilbert White. Mr. Flagg's essays want the simplicity and naturalness and geniality of the Letters of that minute observer.

The illustrations of New England scenery are beautiful specimens of the heliotype process, and add much to the interest of the work. An index is appended containing both the common and the scientific names of the birds referred to in the work, but why should so carefully "got-up" a book have been printed without a table of contents?

Practical Guide to Carlisle, Gilsland, Roman Wall, and Neighbourhood. By Henry Irwin Jenkinson. Also, *Smaller Practical Guide.* By same author. (London: Edward Stanford, 1875).

MR. JENKINSON has succeeded in accomplishing what he has aimed at; he has written a really "useful, entertaining, and instructive" guide-book to the district indicated in the title. This district, of no very great extent, abounds in varied interest, and to those who desire to visit it we could recommend no more valuable companion than Mr. Jenkinson's "Practical Guide." He has evidently taken pains to make himself personally well acquainted with the localities he describes, and has diligently collected all the historical and other associations which add interest to the various points to be visited. To antiquaries, his "Walk along the Roman Wall from Coast to Coast" will be specially interesting, and with this book in one's hand we could imagine no more interesting and instructive walk for a summer holiday. The difference between the larger and smaller Guide is, that the former contains an additional eighty pages on the Local Names and the Natural History—Geology, Mineralogy, Botany, Entomology, and Ornithology—of the district, which adds to its value from a scientific point of view. Both books contain an excellent map of the county from coast to coast, embracing a distance of several miles on each side of the Roman Wall. We commend the Guide as the best to be had for the district to which it refers.

North Staffordshire Naturalists' Field Club. Annual Addresses, Papers, &c. With Illustrations. (Hanley: William Timmis, 1875.)

THIS club has now been in existence for ten years, and judging from the list of papers read and excursions made, has evidently carried out with creditable faithfulness the object for which it was established—the study of the natural history and antiquities of the neighbourhood. The volume before us contains a selection of some of the principal papers read at the Club meetings during these ten years, and, as a whole, they reflect credit on the diligence, intelligence, and knowledge of the authors. Both the papers on general and those on local subjects contain much valuable material, quite deserving of publication, and the latter especially will be useful to those who want information on the natural history and antiquities of Staffordshire. One of the most interesting general papers is by Dr. J. Barnard Davis, "On the Interments of Primitive Man," which is illustrated by some beautifully executed woodcuts. Of the papers on local subjects, we may mention "Notes on the Fossil Trees in a Marl Pit at Hanley," by John Ward, F.G.S.; "The Geology of Mow Cop, Congleton Edge, and the surrounding district," by J. D. Sainter, F.G.S.; "On the absence of Waterfalls in the Scenery of North Staffordshire," by J. E. Davis; and "On the Organic Remains of the Coal Measures of North Staffordshire," by John Ward, F.G.S. Appended is a considerable list of Macro-Lepidoptera taken and observed in North Staffordshire by members of the Club, by T. W. Daltry, F.L.S. The illustrated paper on Croxden Abbey is a valuable one of its kind.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The India Museum

In your notice of the various transfers of the India Museum (vol. xii. p. 192), you do not allude to the somewhat important fact that from 1869 up to the recent opening of the new museum the whole of the Natural History Collections have been kept in closed boxes in the cellars of the India Office.* This has been a grievous wrong to working naturalists, who have constantly required access to typical specimens to solve various points of inquiry.

Again and again the attention of the authorities of the India Office was called to this state of affairs without effect, and naturalists cannot give too much credit to Lord Salisbury and the present Administration for putting an end to the scandal that existed so long.

Unfortunately, however, as I prophesied, it has been found on opening the boxes that some of them have been attacked by moth, and that valuable specimens have perished.

July 9 P. L. Sclater

Irish Cave Exploration

During the last few weeks Dr. Leith Adams, F.R.S., and myself have been exploring an ossiferous cave at Shandon, near here, under a grant from the Royal Irish Academy. Bones of mammoth, reindeer, bear, wolf, horse, and hare, were found in the *débris* of a quarry here in 1859, and are now in the Royal Museum, Dublin. We have worked through a considerable quantity of limestone breccia and stalagmite, in which and in a thin underlying deposit of cave-earth we have found numerous bones of the above-mentioned animals, indicating at least two individuals of mammoth, eighteen of reindeer, and five of horse, for which latter this is as yet the sole recorded locality in Ireland. The bones of bear show extreme age and signs of disease, and we have found the cast antler of a reindeer. Some of the bones have been gnawed, probably by wolves, and many have been broken by the falling-in of the roof of the cave. Though we have broken into a large chamber, we are as yet unable to form a clear conception of the original form of the cavern. A full account of the cave previous to the present exploration was given by Prof. Harkness in the *Geological Magazine* for June, 1870. G. S. Boulger

Dungarvan, Co. Waterford, July 11

Sea-power

Will you allow me to ask your readers one or two questions upon a subject which may ultimately belong rather to an engineering than to a purely scientific journal, but which at present has not, I believe, passed into the hands of practical men? I wish to know:

1. Where—if anywhere—use is made of the movements of the sea as motive powers?
2. Where I can find the latest and fullest information upon this subject?

I have an impression that a paper on the subject appeared in one of the volumes of Nature, but I cannot find it. The latest paper on which I can now put my hand is M. Cazin's lecture on "Les Forces Motrices," in the *Revue des Cours Scientifiques* of Feb. 19, 1870. The lecturer mentions the failure of the *moulins de marée*, and gives a description, with diagram, of M. Tommasi's proposed *flux moteur*.

It has long appeared to me that the immense importance of the question as to the possibility of utilising sea-power has not been sufficiently recognised. The practical solution of this question would not only give to England an inexhaustible motive power, but would also, to a considerable extent, solve at once such problems as are connected with the rapid consumption of our coal, the pollution of our rivers in manufacturing districts, the unhealthy and immoral massing of our working classes in dirty and smoky towns and cities, &c. Moreover, the space covered by the sea-side factories would in many instances be merely the almost waste border-land between sea and field.

Giessen, June 30 A. R.

Sea-Lions

It will be no doubt interesting to your readers to learn that a pair of Sea-Lions have just been added to the collection of animals in the Jardin d'Acclimatation, Paris. They are said to have been brought from the North Pacific, and are marked *Otaria stelleri*, but I think from their small size and long narrow heads that the species is more probably *Otaria ursina*, the Northern Sea Bear, whose principal habitat is the Pribylov group. They are quite young, and the female is larger than the male.

The administrative committee of the Garden has caused a large tank to be built for their reception similar to that in our Zoological Gardens, only rather larger. They seem in excellent health, and it will be interesting to see whether they breed in captivity.

They have no special attendant, so far as I could see, as the Sea-Lions at our Gardens have, and are therefore only fed at stated times. On the day of my visit the keeper was late, and the female became hungry. She gave vent to her feelings by a curious cry, a prolonged "Ah—a—a—ah," repeated at short intervals—something like the bleating of an angry sheep.

It is to be regretted that these animals were not secured for our Gardens, where the best method of managing them is so thoroughly understood, and where consequently the experiment of breeding might have been tried with a better chance of success than elsewhere. J. W. Clark

Museum of Zoology and Comparative
Anatomy, Cambridge, July 11

Hereditary Affection of a Cat for a Dog

I have reared a fine mastiff. He is now three-and a-half years old. When quite a puppy he and a kitten evinced a strong liking for each other. The kitten, when able to leave her mother, fixed her residence in the dog's kennel, and never seemed happy when away from her large friend. She ate her breakfast out of the dog's bowl, and slept in his kennel with his paws around her. She used to catch mice and young rats, and carry them to him, and seemed quite pleased when he accepted friendship's offering. One morning I observed the cat preparing a bed with straw in the corner of the kennel—an ordinary wooden one, 4 feet by 2½ feet. As she was going to have kittens, I thought she intended making the kennel her nursery, and "Cato" (the dog) her head nurse. Such proved to be the case. She brought forth five kittens, and there they lay for some time. The mother frequently went away for hours, leaving the dog to look after her family. I many times stooped down to examine them, and "Cato" stood by my side quite proud of his charge. The poor cat came to an untimely end eighteen months ago, but the only surviving kitten of the five named above is as fond of the dog as her mother was. She brings mice, young rats, and rabbits, and lays them down before "Cato," and looks beseechingly till he takes them. She constantly plays with him and gets on her hind legs to look fondly into his face, while he puts his paws round her as he used to do to her mother.

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* See Nature, vol. vii. p. 457.

She must have *inherited* this affection from her mother, as she was too young to have imitated her mother's actions at the time of her death.

H. G.

Clent, July 13

Scarcity of Birds

I SHOULD much like to know whether blackbirds and thrushes are scarce in other localities this year; because they have most unaccountably vanished from this neighbourhood, with the exception of a very few stragglers. Our cherries and strawberries are untouched. I have not observed a single blackbird or thrush in our garden or pleasure-grounds since the fruit ripened, though every other year we captured several in the cherry-nets, and shot many others.

R. M. BARRINGTON

Fassaroe Bray, co. Wicklow, July 12

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—Of the three stars to which Col. Tennant draws attention as being probably variable ("Monthly Notices R.A.S.," June 1875), B.A.C. 740 appears more especially deserving of regular observation. The B.A.C. has adopted the magnitude assigned by Groombridge, 6; other estimates are:—Hevelius, 6; Fedorenko (Lalande, 1789 November), 8; Piazzi, 8, by seven observations; Schwerd, 8½; Taylor, in 1834 or 1835, in vol. iii. of "Madras Observations," 7 (he calls the star 21 Cephei); Carrington, 8·1; the Radcliffe Catalogues, 7·5; and Durchmusterung, 8·4. With regard to the observation of Hevelius, which has been assumed to refer to this star, it may be remarked that the position given in his Catalogue for 1660, where it is No. 46 in Cepheus, does not well agree with the place of the Redhill Catalogue for B.A.C. 740, the difference of position amounting to 16′; nevertheless it is not easy to identify the star observed by Hevelius with any other in the modern catalogues. In the cases of the stars B.A.C. 4166 and 4193, also noticed by Col. Tennant, the estimates of magnitude from the epoch of Schwerd's observations to the present time appear pretty accordant. [In comparing the magnitudes assigned in different catalogues to the naked-eye stars it is necessary to bear in mind that in Argelander's Uranometria, and in Heis and Behrmann, 6·5, 5·4, &c., apply to stars which are judged to be somewhat brighter than an average sixth or fifth magnitude, and are not to be understood decimally, as is the case in the "Durchmusterung."]

THE DOUBLE-STAR Σ 1785.—The proper motion of this star is investigated in Argelander's researches, Bonn Observations, vol. 7. He remarks: "Die Begleiter geht mit," and of this there can be no doubt, since in the interval between Struve's first measures and the last published by the Baron Dembowski, the amount of proper motion, according to Argelander's values, would be – 20″·9 in R.A. and – 2″·4 in Decl. But the relative fixity of the components, which might have been surmised from Argelander's comparison of his differences of R.A. and Decl. for 1867·34, with those deduced from Struve's angle and distance in 1830, is clearly refuted by the recent measures. Thus we have—

Struve	1830·12	Position	164°·43	Distance	3″·487
Dembowski ...	1870·81	,,	199°·60	,,	2″·431

Perhaps it is not yet practicable to decide whether this relative change is due to slight difference of proper motion or to the binary character of the star, but it is evidently one that should be regularly measured. The position for the beginning of the present year is R.A. 13h. 43m. 24s., and N.P.D. 62° 23′·6.

THE TOTAL SOLAR ECLIPSE, 1927, June 29.—We believe the Rev. S. J. Johnson, of Upton Helions, Devon, was the first who pointed out the probable totality of this eclipse for a short interval in this country. It is one of those eclipses in which the moon's augmented semidiameter exceeds that of the sun by a small quantity, even where the sun is on the meridian. The following are approximate elements:—

Conjunction in R.A. 1927, June 28, at 18h. 27m. 14s. G.M.T.

	°	′	″	
R.A.	97	6	12	
Moon's hourly motion in R.A.		37	27	
Sun's ,, ,, ...		2	36	
Moon's declination	24	4	35	N.
Sun's ,, ...	23	17	17	N.
Moon's hourly motion in Decl.		1	18	N.
Sun's ,, ,, ...		0	7	S.
Moon's horizontal parallax		57	55	
Sun's ,, ...		0	9	
Moon's true semidiameter		15	47	
Sun's ,, ...		15	44	

The sidereal time at Greenwich noon on June 29 is 6h. 26m. 17s., and the equation of time 3m. 3s. subtractive from mean time. The middle of general eclipse at 18h. 23m. 17s.

Hence the following points on the central line:—

	°	′			°	′			°
Long.	3	21	W.	Lat.	54	11	N.	Sun's zenith distance	78·5
,,	0	45	W.	,,	55	40		,, ,, ,,	76·3
,,	1	30	E.	,,	57	3		,, ,, ,,	74·5
,,	3	32	E.	,,	58	15	N.	,, ,, ,,	72·8

In 1° 37′ W. and 55° 12′ N. totality begins according to the above elements, June 28 at 17h. 19m. 31s. local mean time, and continues only nine seconds. It will be seen that the track of the central line in its passage over England is from Windermere, a little north of Morpeth, to the Northumberland Coast; it appears to just escape the Isle of Anglesey, but our data are not quite definitive.

MINOR PLANETS.—M. Stéphan has calculated elements of No. 146, discovered by M. Borrelly, from the Marseilles observations of June 9, 18, and 29, which give as a first approximation to the period of revolution, 1627 days; the planet has been named *Lucina*. Euphrosyne is in opposition about this time, with 57° South Declination; this body makes one of the widest excursions of any in the group, and may at times be found in Ursa Major. Daphne is the brightest of the small planets now near opposition.

SCIENCE IN GERMANY

(*From a German Correspondent.*)

IN continuation of the last report (p. 152) we make the following further communication on Götte's "History of Development." As we have already mentioned, Götte deduces the structure of the embryo from the difference in size and position of the parts resulting from the division of the ovum. He supports this theory by the following observations. In the case of all ova, first of all a difference shows itself in the vertical axis, the parts round the upper pole being smaller and generating quicker than those round the under pole. The ratio of displacement is therefore also much greater in the upper hemisphere; and as this one expands concentrically it overgrows downwards the more bulky lower hemisphere, or causes it to bulge inwards, so that from the ovum which divides into many cell-like pieces, results a beaker-shaped formation with double sides; *these are the two original germ-layers*. The space enclosed by the inner germ-layer is the intestinal cavity; the whole formation we call *gastrula* after Haeckel. As the causes of the formation of the two germ-layers are the same for all animals consisting of more than one cell (matazoa), according to Götte's view, the form of development of the gastrula is therefore common to all, however indiscernible it may often be in the outside appearance. The cause of this is partly that the above-mentioned difference between the upper and lower hemispheres of the ovum varies in magnitude. If this difference is small, the result will be that only a moderate part of the lower hemisphere will be pressed inward, the inner germ-layer remaining simple, as for instance with the lower polypi, which on the whole consist of two layers of cells. As the energy of the inward pressure increases, a third germ-layer, the so-called middle one, is split off the stronger inner one; this third one, from being a simple intermediary layer, may develop and originate many and important organs. If in the dividing ovum only the difference referred to in the vertical axis exist, the gastrula is naturally formed equally in all directions between the two poles, so that if further transformations take place, these likewise occur equally in all directions from the intestinal cavity and its principal axis, and therefore in radiated planes or lines. Thus the difference in the first axis of the ovum, if it acts by itself, always leads to a radiated structure of body which we find with Polypi, Medusæ, Echinoidea, and their relatives. Yet the higher developed representatives of these classes already show here and there, and in unimportant points, indications of a transition to a higher type. If we suppose the two horizontal axes of the ovum to be unequal, then the formation of the gastrula must naturally be unequal likewise. The inequality, which with many of the Vermes already shows itself during the first divisions of the ovum, causes the gastrula to extend in one direction more than in any other, and thus to receive another principal axis. If at the same time the two sides precede in development the other parts, two symmetrical masses are formed, situated opposite one another (germ-streaks), and which approach each other more or less on the stomach side, and there produce certain principal organs. To this transverse divisions may be added, as in the Arthropoda; or this may not occur, as in the Mollusca. Vertebrata finally do not show the preponderance of the first formation on two opposite symmetrical sides of the ovum, but only on one, where the odd germ-streak is situated and indicates the future back. In a manner similar to that of the typical foundation of the embryo, Götte tries to deduce all other phenomena of development not from hypothetical causes of inheritance, but directly from the laws of the formation of the ovum; as, for instance, the whole development of the different organs and tissues. Any essential change in a certain animal species must then be deduced from a change in the laws of formation, which are peculiar to the ovum, *i.e.* its first cause lies in the ovum, and the live animal can never transfer newly-gained changes of form directly to the law of formation of its germs, nor thus cause its descendants to inherit them.

NEW DISCOVERY IN CONNECTION WITH THE POTATO DISEASE

THERE has been hitherto one "missing link" in our knowledge of the life-history of the potato-blight, *Peronospora infestans*. The non-sexual mode of reproduction by conidia or zoospores has long been known; but the sexual mode of reproduction has eluded observation. This link has now been supplied through the researches of Mr. Worthington Smith, who described his discovery in a paper read at the last meeting of the Scientific Committee of the Royal Horticultural Society, and published at length in the *Gardener's Chronicle* for July 10. He finds the female organs, the "resting-spores" or unfertilised "oospores," and the male organs or "antheridia," in the interior of the tissue of the tuber, stem, and leaf, when in a very advanced stage of decay; and he has actually observed the contact between the two organs in which the process of fecundation consists. In some remarks made at the meeting of the British Association last year by one of our high authorities, it was suggested that we have in the *Peronospora* an instance of the phenomenon not infrequent among fungi, known as "alternation of generations;" and that the germination of the true spores of the potato-blight must be looked for on some other plant than the potato. Mr. Worthington Smith has, however, looked nearer home, and has proved that the suggestion is not at all events verified in all cases. It is matter of congratulation that, after the lapse of a period of nearly thirty years since the publication of the first important memoir on the subject, this discovery—important alike from a scientific and a practical point of view—has fallen to one of our own countrymen, notwithstanding the foreign aid invoked by the Royal Agricultural Society in settling the still unsolved problems connected with this perplexing pest.

HISTORY OF THE PLAGIOGRAPH

I SHOULD like to add a few words to my description of the instrument called the Plagiograph [*] (the *g* to be pronounced soft, like *j*, as in Genesis, Plagiarist, Oxygen) in NATURE, vol. xii. p. 168, for the purpose of explaining the order of ideas in which it took its rise, and also a very beautiful extension of another recent kinematical invention to which it naturally leads the way, and which, thus generalised, I propose to term the Quadruplane.

The true view of the theory of *linkages* [†] is to consider every link as carrying with it an indefinitely extended plane, and to look upon the question as one of relative [‡] motion which may be put under this form: When a *complete* linkage (meaning thereby a combination of jointed planes capable of only a definite series of relative movements) is set in motion, *what is the curve which any point in one of these planes will describe upon any other?*

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[*] It may be questioned whether a new-born child can have a history. Perhaps it might have been more correct to have used for my title, "History of the Birth of the Plagiograph," but this would have been long; moreover, the Plagiograph proves to be an unusually precocious child, having in its very cradle given birth to a greater than itself, the Quadruplane, a full-grown invention described in the sequel of the text.

[†] It is quite conceivable that the whole universe may constitute one great linkage, *i.e.* a system of points bound to maintain invariable distances, certain of them from certain others, and that the law of gravitation and similar physical rules for reading off natural phenömena may be the consequences of this condition of things. If the Cosmic linkage is of the kind I have called complete, then determinism is the law of Nature; but, if there be more than one degree of liberty in the system, there will be room reserved for the play of free-will. We shoud thus revert to the Aristotelian view under a somewhat wider aspect of circular (the most perfect because the simplest form of motion) being the primary (however recondite) law of cosmical dynamics. Speaking of cosmical laws brings to my mind a reflection I have made upon the new chemical theory of atomicity. Suppose it should turn out that the doctrine of *Valence* should be confirmed by experience, and that the consequent logico-mathematical theory of colligation containing the necessary laws of consecution, or if cone pleases so to say of cause and effect should plant its foot and introduce a firm basis of predictive science into chemistry, how beautiful will be the analogy between this and the physical law of inertia! which really merely affirms the fact of each atom or point of matter carrying about with it a certain number, denoting its communicative and inverse receptive faculty of motion; for in such case Valency, also affirming a numerical capacity for colligation, will be the exact analogue in chemistry to Inertia in the theory of mass motion, and might properly assume the name of chemical inertia. Social individuals differ as egregiously as Isomers in their capacity for forming multifarious attachments.

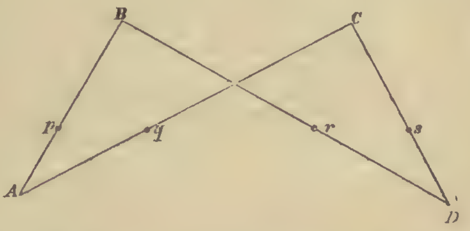
[‡] I believe it is to Mr. Samuel Roberts that we are indebted for the idea of passing from mere copulated links to planes associated with the links, and for the observation that the order of the corresponding Graphs is not thereby augmented. The substitution of the more general idea of linkage for link-work, and of isolating completely the conception of relative in lieu of absolute motion, is due to the author of these lines. Take the case of a Quadruplane in which the four joints in their natural order of sequence form a contra-parallelogram. It is well known (and the fact has been applied to machinery under the name of "the parallelogram of Reulleux") that the relative motion of an opposite pair of planes may be represented by causing two curves to roll upon each other; but I add that this may be done simultaneously for both pairs of planes, giving rise to a beautiful and previously unthought-of double motion of rolling (without slip) between two ellipses for one pair and two hyperbolas for the other pair of planes. This is an immediate deduction from the conception of purely relative motion.

NOTE.—In the description of the plagiograph, for *pointed* parallelogram, p. 168, second column, line 14, lege *jointed* parallelogram. Also a dotted line should be drawn in Fig. 1 connecting the points o and P′.

In this mode of stating the question, the lines joining the pivots round which the planes can turn correspond to the jointed rods of the common theory. Fix any one of the planes, and the linkage becomes a link-work, or, to speak with more precision, a piece-work.

The curve described by a point in one plane upon any other plane has been termed by me with general acquiescence a Graph, and to keep the correlation closely in view, I have proposed to call the describing point the Gram.* We may further understand by canonigrams describing points taken in the lines connecting the joints and their corresponding curves, canonigraphs; Grams lying outside these lines and their appurtenant Graphs may be termed Epipedograms and Epipedographs; or, if these names are found too long for use, Planigrams and Planigraphs.

Now consider more particularly the generalised form of the linkage which corresponds to three-bar motion, of which Watt's parallel motion (so-called) offers a simple instance. If we were to revert to the old notion of link-work we should say that a three-bar motion is obtained by fixing one of the sides of a jointed quadrilateral of any form; but adhering to the more general conception of the matter here set forth, we may describe it as resulting from the fixation of any one of the planes of a quadriplane, *i.e.* a system of four planes connected together by four joints. Mr. A. B. Kempe, who has brought to light magnificent additions to Peaucellier's ever memorable discovery of an exact parallel motion in a paper which I have had the pleasure of presenting to the Royal Society of London, in the course of conversation with me made the very acute and interesting remark that in an ordinary 3-bar motion, supposing the distance between the two fixed centres to be given, and the lengths of the two radial arms and the connecting rod to be also given, the order in which these three latter elements are arranged will not affect the nature of the canonigraphs described. Whichever of the three lengths is adopted as the length of the connector and the remaining two as the lengths of the radial arms, the very same system of curves will be described in all three cases so far as regards their form: every canonigram in the arrangement will have a canonigram corresponding to it in each of the other arrangements such that the corresponding curves described will be similar and similarly placed—a most remarkable, and, for the purposes of theory, an exceedingly important observation; but, as Prof. Cayley observed, when once stated, a self-evident deduction from the principle of the ordinary pantigraph.† It therefore occurred to me that a corresponding theorem ought to hold for all graphs whatever—for plagiographs just as well as for canonigraphs; and by a very simple application of the general double-algebra method of *Versors*, I found that this would be the case, the only difference being that now the corresponding graphs, instead of being similar and similarly situated, would be similar but not similarly situated; in other words, that the lines joining the centre of similitude with the corresponding points, instead of coinciding in direction, would make for each particular graph a constant angle with each other. Thus I passed from the conception of the common Pantigraph to that of the Quergraph, or Plagiograph, or Skew Pantigraph, as the new instrument described in the previous article may indifferently be called. I now come to the second part of my story, and proceed to explain the remarkable extension a theorem analogous to and naturally suggested by the Plagiograph gives of Mr. Hart's remarkable discovery of a *cell* consisting of only four jointed rods which possesses the same property of reciprocation as Peaucellier's six-sided cell.



This cell is exhibited in the figure above. The four jointed rods AB, AC, CD, BD are equal in pairs, AB and CD being equal, also AC and BD. In fact, the figure is nothing else but a jointed parallelogram twisted out of its position of combined parallelisms, and may be termed a contra-parallelogram. When the cell is in any position whatever, imagine a geometrical line to be drawn parallel to the lines joining A and D or B and C (for these lines will obviously always remain parallel to each other), cutting the four links in the points *p*, *q*, *r*, *s*.

Now take up the cell and manipulate it in any manner you please so as to change its form, the same four points *p*, *q*, *r*, *s* will always remain in the same straight line, the distances *pq* and *rs* will always remain equal to one another, and the product of *pq* by *pr*, or, which is the same thing, of *sr* by *sq*, will never vary, so that *pr* remains (so to say) a constant inverse of *pq*, and *sr* of *sq*—the actual value of the constant product (called the modulus of the cell) being the difference between the squares of the unequal sides of the contra-parallelogram, multiplied by the product of the segments into which any one of the links is separated by the points *p*, *q*, *r*, or *s*, and divided by the square of such link. Now Mr. Kempe and myself—he by the free play of his vivacious geometrical imagination, I by the sure and fatal march of algebraical analysis—have arrived at the following beautiful generalisation of Mr. Hart's discovery. On AB, BD, DC, CA describe a chain of four similar triangles, the angles of which are arbitrary, but looking towards the same parts, and so placed that the equal angles in any two contiguous triangles are adjacent—call the vertices of these triangles P, Q, R, S (which will be in fact the analogues of the points *p*, *q*, *r*, *s* before mentioned): then it will be found that the figure PQRS will be a parallelogram whose angles are invariable, and the product of whose unequal sides is constant; in a word, a parallelogram of constant area and constant obliquity.*

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* Gram is intended to suggest the notion of a *letter* discharging the duty of a point. In inventing new verbal tools of mathemathical thought, the following are the rules which I bear in mind:—1. The word must be transferable into the common currency of the mathematical centres of Europe, France, Germany, and Italy. 2. It must enter readily into combinations and be susceptible of inflexion fore and aft. 3. It should contain some suggestion of the function of the idea intended to be conveyed. 4. It should by similarity in quality or weight of sound conjure up association with the allied ideas 5. When all these conditions are incapable of being simultaneously fulfilled, they should be observed as far as possible, and their relative importance estimated according to the order in which they are written above.

† Suppose AB, BC, CD to be three jointed rods fixed at A and D. Choose either of the fixed points, say A, and complete the parallelogram ABCB′A, regarding CB′, B′A as two additional jointed rods; through A draw any transversal, cutting the two indefinite straight lines AB, BB′ in P and P′ respectively; then whatever curve P describes when the system is set in motion, P′ by the principle of the common Pantigraph will describe a curve similar and similarly situated thereto, A being the centre of similitude. Now, it will be noticed that AB′CD is a system of four jointed rods in which the lengths AB′, B′C are the same as the lengths AB, BC in inverted order, viz., AB′ = BC, and B′C = AB, and as we may proceed from the point D equally well as from A, it follows that all the six interchanges may be rung between the three lengths AB, BC, CD. This is the proof of Mr. Kempe's admirable theorem; but does the simplicity of the principle involved take away in any degree from the beauty of the result, or rather, is not the interest of the conclusion enhanced by the simplicity of the means by which it is arrived at? In fact, as Kant has observed, the groundwork of all mathematical proof consists in putting things together by a free act of the imagination; and the essence of Euclid is to be sought in the constructions which antecede the formal proofs. The real proof is the construction, and no one has the right to call Mr. Kempe's discovery "a truism."

The modulus, or constant product of the sides, follows the same rule as in the special case, except that for the product of the segment of a link divided by the square of its entire length, must be substituted the product of the sines of the angles adjacent to any link divided by the square of the sine of the angle subtended by it.

Just as in the first case $pq.pr$ and $sr.sq$ are constant, so now PQ.PR and SR.SQ are constant; but whereas pq coincided in direction with pr and sr with sq, PQ and PR, like SR and SQ, remain inclined to each other at a constant angle; in a word, as the Plagiograph is to the Pantigraph, so is the Sylvester-Kempe Inverter or Reciprocator to Mr. Hart's.† Do not let it be supposed that this new reciprocator is to be consigned to the limbo of barren mathematical generalities—very far from it; it is very likely indeed to find a most valuable application to mechanical practice, and to subserve the purposes of that immediate "Utilitarianism"‡ so dear to the Philistine mind; for, as by means of Mr. Hart's Quadrilateral, when one of the four named points, say p, is absolutely fixed, and one of its non-conjugate points, say r, is attached to the end of a radius so centred and of such a length that the path of r is a circle which, *geometrically* completed, would pass through p, the remaining conjugate point q will be forced to describe a straight line perpendicular to the line joining the two fixed points—so by means of our Quadruplane, when P is fixed and R made to move in the arc of a circle passing through P, the point Q may be made to describe a straight line having any *desired obliquity* to the line of centres, the amount of such obliquity depending on the magnitude of the supplemental equal angles P, Q, R, S. Thus the Plagiograph (and in the first instance Mr. Kempe's notice of the homœographic commutability of the lengths of the connecting rod and the radial bars in ordinary three-bar motion) has led by a devious path to the construction of a three-piece-work giving the most general and available solution of the problem of exact parallel motion that has been discovered or that can exist—I say the most available, for it is evident, in general, that piece-work must possess the advantage of greater firmness and steadiness from the more equal distribution of its strains over ordinary link-work.

The Peaucellier and Hart cells, duly mounted, afford the means by obvious methods of adjustment to cut straight lines at any distance from either of the fixed centres, but confined to lying perpendicular to the line of centres; whereas the Quadruplane puts it into our power with one and the same instrument affected with simple means of adjustment to make straight cuts (and, if desired, two parallel ones simultaneously) in all directions as well as at all distances in the plane of motion. So again the Plagiograph enables us to apply the principle of angular repetition (as, for instance, in making an ellipse with dimensions either fixed or varying at will, successively turn its axis to all points of the compass) to produce designs of complicated and captivating symmetry from any simple pattern or natural form, such as a flower or sprig; and as the head of a house at Oxford in the good old port-wine days was heard to complain about the electro-magnetic machine, that "he feared it would place a new weapon in the hands of the incendiary" (the power of Swing being then rampant in the land), so, but with better reason and upon the highest authority, it may be predicted that this simple invention will be found to place a new and powerful experimentative and executory implement in the hand of the engine-turner, the pattern-designer, and the architectural decorator.

J. J. SYLVESTER

Athenæum Club, and 60, Maddox Street, W.
July 5.

P.S.—I rejoice to be able to state that the Institute of France has quite recently adjudged its great mechanical prize, the "Prix Montyon," to Col. Peaucellier for his discovery of an exact parallel motion when a lieutenant in 1864. The first practical application of this discovery, made by Mr. Prim under the sanction of Dr. Percy, may be seen daily at work in the Ventilating Department of our Houses of Parliament. The workmen there, who never tire of admiring its graceful and silent action, have given it the pet name of the "Octopus," from some fancied resemblance between its backward and forward motion and that of the above-named distinguished Cephalopod. I feel a strong persuasion that when the inertia of our operative classes shall have been overcome, this application will prove to be but the signal, the first stroke of the tocsin, of an entire revolution to be wrought in every branch of construction; and that machinery is destined eventually to merge into a branch of the science of Linkage in the sense in which that word is used in the text above.

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* I early noticed the analogy between M. Peaucellier's six-linked reciprocator and the primitive form of the pantigraphic proportionator formed by two parallelograms having an angle and the directions of its two containing sides in common, also therefore consisting of six links; and indeed pointed out that, starting (to fix the ideas) from a negative Peaucellier-cell (such as is in successful use in the Houses of Parliament for ventilating the brains of our representative and hereditary legislators), we have only to unfix the two interior links from the angles, to which they are attached, and attach them instead to two sides of the containing lozenge, so as to be parallel to the other two sides; and we pass from a Reciprocator to the comparatively barren Proportionator. Now as a Proportionator (the Pantigraph in common use) exists with only four sides, it ought to have been inferred as fairly probable that a Reciprocator also might be discovered having only four sides, *i.e.* by analogy, the probable existence might have been inferred of a Hart cell—the contra-parallelogram first imagined by Mr. Samuel Roberts, but rediscovered and hugged with the affection of a supposed original discoverer, and warmed into new and unsuspected uses by its foster-parent Mr. Hart. I shall have no difficulty in finding a generalisation of the Peaucellier-cell standing to it in the same relation as the Quadruplane does to the Hart-cell, and similarly for the Proportionator, so that we shall have the fourfold proportion—Peaucellier-cell : Hart-cell : Quadruplane : New Peaucellier-cell : : Old Pantigraph : Common Pantigraph : Plagiograph : Oblique Old Pantigraph; but, except as completing a chain of analogies, the last terms in each quatrain will probably not prove of any practical importance.

† In the case of a 3-piece motion whose fundamental linkage (*i.e.* the quadrilateral formed by the lines joining the pivots and the fixed points in their natural order of succession) is subject to the condition that either the two pairs of opposite sides or two pairs of contiguous sides are equal for each pair, the Planigraph (leaving out of account its circular portion) is the inverse of a conic. In the first case (that of the contra-parallelogram) the position of this node is seen immediately to be the opposite to the Planigram in respect to the centre of the figure in its untwisted (*i.e.* parallelogrammatic) form. In the second case, that of the so-called kite-form, it was found to be far from easy to determine its position. Even our Cayley did not quite succeed in determining it from the analytical equations, and it was reserved for M. Manheim to deduce it geometrically by a most elegant but very elaborate construction given in a paper inserted in the Proceedings of the Mathematical Society of London. By the aid of the reciprocity established by me above we pass at once from the case of the contra-parallelogram to that of the kite-form, and the problem literally solves itself as easily as a musical passage can be transposed from one key to another. It is to that profound mathematician, Mr. Samuel Roberts, that we are indebted for bringing to light these two cases of 3-bar motion, in which the general 3-bar sextic Graph breaks up into a circle, and the inside of a conic, and I have proved that no other such cases exist. Mr. Roberts's papers are inserted in the Proceedings of the London Mathematical Society, which is indebted for its existence, at least in its present form (being originally little more than a juvenile mathematical debating society among the students of University College), to the organising talents of Mr. Hirst, who has reason to be proud of his progeny. Similar societies on a precisely similar basis, and adopting the rules of its elder sister, have been subsequently founded in Paris, Warsaw, and, I believe, other capitals in Europe, and, it is safe to predict, are destined to play no unimportant part in the further evolution of our time-honoured yet ever young, ever fresh, and self-renovating science—Othello, Hamlet, and Romeo all in one. Meanwhile, in the University supposed to be peculiarly dedicated to the advance of mathematical science, a young and very promising mathematician (whose name shall not be divulged) *àpropos* of a movement kindly attempted, without my being previously consulted, to place me in a position where, in the vicinity of our central luminary, I might have been in my proper place, and helped to reflect some portion of his rays upon surrounding bodies, wrote to me lately: "You cannot imagine the bitter prejudice that prevails here against pure mathematics, &c." I freely forgive those, "the bigots of a narrow creed," who entertain such sentiments, knowing that "they know not what they do."

‡ What would our English statesmen say to the conduct of the proverbially parsimonious Prussian Government and the nineteenth century Richelieu, "dertolle Bismark" in appropriating a million and a half of marks (75,000*l*. sterling) placed at the free disposal of the modern Aristotle, Helmholtz, for constructing the bare shell alone of the new Physical Laboratory at Berlin! If such an appropriation were proposed at home, would there not run through the land a frantic shriek or muttered low of disapprobation at such a wanton waste of the public funds on mere speculative science?

CHARCOAL VACUA*

(*From a Correspondent.*)

PROF. DEWAR began his discourse by describing the different processes which have been adopted for obtaining very perfect vacua, and referred to a paper regarding this matter, read by Prof. Tait and himself before the Society last year.

By the ordinary air-pump the exhaustion can only be obtained to ⅕ of an inch, *i.e.* 1/150 of the ordinary pressure.

Regnault, in some of his experiments, after exhausting with the air-pump, boiled water, and when the water had evaporated, sealed the vessel, and then broke a flask inside containing sulphuric acid, and so the water vapour was absorbed.

Dr. Andrews' way is a revival of one due to Davy, viz. to fill and exhaust twice with carbonic acid after the pump exhaustion, and then by caustic potash to fix the CO_2 which is left.

Professors Tait and Dewar's method is to take advantage of the power charcoal has of condensing gases; while the exhaustion, by means of a mercury pump, is going on, the charcoal is kept heated; when the exhaustion has been carried as far as possible, the vessel is sealed, and as the charcoal cools, it condenses the very small residue of gas there may be present, and this can again be temporarily driven out by heating the charcoal. The test they have employed to gauge the perfection of their vacuum has been to see if it will allow an electric spark to pass. It is well known that at the ordinary atmospheric density it requires considerable tension for a spark to pass through air, and as the density diminishes, the spark passes more easily; but when a certain point is reached the difficulty again increases, and in a very perfect vacuum no spark passes at all. Two wires, ¼ inch apart, in one of Tait and Dewar's exhausted tubes would not allow a spark to pass, although a powerful coil was employed.

Prof. Dewar went on to say that the effect of light and heat had been tried by many experimenters, on magnets and delicately suspended bodies, and in the *Edinburgh New Philosophical Journal* for 1828 there is an interesting account of some experiments performed by Mark Watt on the same subject, with apparatus little differing in appearance from that now used by Mr. Crookes.

Recently Mr. Crookes has found some curious results which he seems to think are inexplicable. He found that the action of a beam of light on a delicately suspended glass fibre with a disc at each end was repulsion of the disc when the exhaustion was perfect, but attraction when at ordinary pressures. The discs were light bodies of pith or cork. One side of each was covered with lampblack, the other was white. The first thing to be noticed is that the blackened face is affected much sooner than the white face. Since there was attraction at one density and repulsion at another, it follows that at some intermediate density there is no action at all, and this neutral point depends among other things on the conductivity of the body and the nature of the residual gas.

It will be seen that for delicate action one essential is that the glass of the vessel be thin. The sensibility is also found to increase with the perfection of the vacuum.

The first fact ascertained is that the action follows the law of the inverse square of the distance, that which all radiation obeys. Thus, when the light was 3¾ inches from the beam, the reading was 110, zero 22, deflection 88; at 7½, reading 48, deflection 22, or only about ¼; and when at 11½, reading 33; and as zero changed, reading 33, deflection 9, or only about 1/9.

The next experiment was this. Professor Dewar interposed between the candle and the beam a substance opaque to heat rays. The candle was placed so as to give a large deflection, and then a vessel of ordinary glass was interposed, and the deflection decreased, and on filling the vessel with water, which is almost opaque to heat rays, there was no perceptible deflection left. This shows that when the heat rays are absorbed or prevented from reaching the disc, hardly any action takes place. A layer of water ¼ of an inch thick diminishes the amount of deflection to ⅛ part of the original.

Next a smoked piece of rock-salt was interposed, or a vessel filled with a substance transparent to heat but opaque to light, viz., a solution of iodine in bisulphide of carbon. The deflection was as before, large; on the empty screen being interposed a diminution followed, due to the non-transparency of the glass screen for heat. But when by means of the iodine solution the light rays were cut off there was hardly any further diminution in the deflection. This shows that the light rays may be taken away without any considerable diminution of the action.

Prof. Dewar then proceeded to show that the heating of the disc was the efficient cause of the action.

Two equal discs, one of rock-salt, the other of glass, were attached to the glass fibre. The rock-salt was inactive when the beam was thrown on it; the glass disc was active. The reason is evidently that the rock-salt is not heated, being transparent to heat, whereas the glass is opaque, absorbs the heat and is heated. Unless the shell of the receiver be thin, however, the selective action is very small, as the glass envelope absorbs much of the heat.

The back of the rock-salt disc was then coated with lampblack, and the beam sent through to the blackened side. Yet there would be attraction. The heat and light passes through the rock-salt and is absorbed by the lampblack at the surface of contact. The lampblack is heated up in consequence, but it is so bad a conductor that before this heat can be conducted through the thin coating of lampblack it is conducted through the rock-salt, heats it up, and the action is repulsion. If the lampblack were not so bad a conductor, all the lampblack would be first heated up and there would be repulsion at the other side, or apparent attraction. The subsequent action is due to the giving out heat unequally on the two sides.

The next modification was to substitute for the rock-salt clear sulphur and ordinary sulphur on the other. The peculiarity of clear sulphur is that when acted on by light it resumes the appearance of ordinary sulphur, with a disengagement of heat. A beam was thrown on this, and the effect was, as expected, attraction, the back being heated, and repulsion, there being attraction on the other side. The success of this experiment depends on the way in which the sulphur is transforming.

This suggested to the learned Professors an instrument for detecting the presence of very high violet rays. Have the transparent discs coated with white phosphorus, which is opaque to the ultra-violet rays. There would ensue a chemical action with disengagement of heat, and the result would be a motion of the discs. To show the sensitiveness of the apparatus, it may be stated that an ordinary lucifer-match held at a distance of 4 feet produced instant action, which was observed by means of a telescope. When ether was brought near there was attraction. The disc followed the ether about because there was radiation of heat from the disc. The action is clearly due to the infinitesimal heating of the discs. Reynolds suggested the action was due to the evaporation of some fluid on the surface of the discs. The recoil of the evaporating particles leaving the disc sent it back.

When the action takes place in ordinary pressures it is probably due to convection currents. The air in front of the disc is heated and ascends, there is a vacuum, and hence the disc advances. To understand the action that takes place when the exhaustion is more perfect, we must consider how much gas there is in the vessel. The capacity of the vessel is about a litre or 1000 cubic centimetres. But since we know that the exhaustion has reduced the density to $\frac{1}{4000000}$ of its original, the volume occupied by the residual gas at ordinary pressures would be that of a little bubble $\frac{1}{100}$ of an inch in diameter.

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* By Professors Tait and Dewar. Paper read by Prof. Dewar before the R.S of Edinburgh on Monday, July 12.

Sir Wm. Thomson, T. Clerk-Maxwell, and Clausius have shown that in a gas, at ordinary pressure, the mean or average path between two collisions is about $\frac{1}{10000}$ of a millimetre. When the pressure is reduced to $\frac{1}{4000000}$ the mean will be 400 millimetres, or about a foot and a half. What takes place is this. The particles of the gas are flying about in all directions, with a velocity which depends on the temperature. When they impinge on the heated disc their velocity is increased, they go off with a greater velocity than those which go off from the colder side, and hence there is a recoil of the disc. When the gas is at all dense the particles get a very short way before they are met by another and sent back, and so the velocity gets a common velocity before any visible action takes place. When the gas is rare the particles may get a long way off before they meet others, and so the action becomes perceptible.

In case of cooling they go away with diminished velocity and a negative recoil.

The author of the paper went on to show that the total mechanical action on a square centimetre of black surface derived from the radiation of a magnesium lamp, at a distance of 150 mill., did not exceed a continuous pressure of $\frac{1}{50}$ part of a milligramme, and that the total work done did not amount to the five-millionth part of the available energy received by the movable surfaces.

ADDITION TO OUR KNOWLEDGE OF THE TERMITES[*]

FRITZ MÜLLER has recently published a short but interesting memoir on the larvæ of Calotermes, a genus of Termites, which he describes with his wonted care and accuracy. We cannot, of course, here follow him in detail; but, as is so often the case in the writings of this eminent naturalist, he draws our attention by his descriptions to several points of unusual interest. As occurs in some other insects, the youngest larvæ of Calotermes differ much in form from those somewhat more advanced in age. The form of the younger larvæ may be accounted for on two hypotheses. It may be an adaptation to the mode of life, or it may be the original larval form of the group. In the latter case, Herr Müller considers that it would be an extremely interesting form, because, in his opinion, Calotermes is one of the oldest, if not the oldest, of existing insect genera; since, according to Hagen, the carboniferous Termites described by Goldenburg from the cold strata belong to this group. Under the latter hypothesis, therefore, the younger larvæ of Calotermes would have, as regards insects, an interest similar to that possessed by Nauplius among Crustacea; and, according to Müller, the latter really is the case. The youngest larvæ of Calotermes live with their elder sisters, in the same localities, on the same food, and, in fact, under precisely the same conditions. These older larvæ have, in a word, completely adapted themselves to their dwelling-place and mode of life. Like most animals which burrow in earth, wood, or stone, they are cylindrical in form. Not so the youngest larvæ, which are flattened, and have the thorax laterally expanded. Their structure is, in Müller's opinion, as unsuitable as possible for animals inhabiting wood. This form is therefore probably only possessed through inheritance from far distant ancestors.

It is unnecessary to point out how great is the interest attaching to these larvæ, if Müller's view be correct; nor would I venture to express any dissent from his conclusions. But, I confess, there seems to me a difficulty in comprehending why the younger larvæ have not adapted themselves to their conditions, in like manner as their elders.

May there not possibly be some circumstances which have hitherto escaped observation, and which might render the form of these larvæ not so altogether unsuitable as Müller supposes?

I will just refer to one other point in this interesting paper. The author shows that the main, if not the whole growth of the antenna takes place in the third segment: the two basal ones and the terminal portion remaining almost unaltered. My husband, many years ago (Linn. Trans., 1863), showed this to be the case in the Ephemera (*Chloeön*), and it would be interesting to know whether the same thing occurs among other Neuroptera.

High Elms ELLEN LUBBOCK

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[*] By Fritz Müller.

NOTES

THE Loan Exhibition of Scientific Apparatus at South Kensington, to which we have already referred (vol. xi. p. 301), will open on the 1st of April, 1876, and remain open until the end of September, after which time the objects will be returned to the owners. It will, as we have already intimated, consist of instruments and apparatus employed for research, and other scientific purposes, and for teaching. It will also include apparatus illustrative of the progress of science, and its application to the arts, as well as such as may possess special interest on account of the persons by whom, or the investigations in which, it had been employed. The precise limits are detailed under several sections in a syllabus which has been issued for the information of exhibitors. Models, drawings, or photographs will also be admissible where the originals cannot be sent. The apparatus may, in certain cases, be arranged in train as used for typical investigations; and arrangements will be made, as far as it may be found practicable, for systematically explaining and illustrating the use of the apparatus in the various sections. Forms on which to enter descriptions of objects offered for exhibition may be obtained on application to the Director of the South Kensington Museum, London, S.W. These forms should be filled up and returned as soon as possible, so that exhibitors may receive early intimation as to the admissibility of the objects they propose to send. The cost of carriage of all objects selected for exhibition will be defrayed by the Science and Art Department. It is hoped that institutions or individuals having instruments of historic interest will be good enough to lend them. The following are the various sections into which the Exhibition will be divided:—Arithmetic, Geometry, Measurement, Kinematics, Statics and Dynamics, Molecular Physics, Sound, Light, Heat, Magnetism, Electricity, Astronomy, Applied Mechanics—[as the Exhibition must be regarded as chiefly referring to education, research, and other scientific purposes, it must in this division consist principally of models, diagrams, mechanical drawings, and small machines, illustrative of the principles and progress of mechanical science, and of the application of mechanics to the arts],—Chemistry Meteorology, Geography, Geology and Mining, Mineralogy, Crystallography, and Biology.

MR. SULLIVAN on Tuesday, in the House of Commons, moved with regard to the necessity for having a Museum of Science and Art in Dublin. He, as well as the other speakers, seems to be ignorant of the fact that in addition to its educational staff and appliances, the Royal College of Science in Dublin possesses the germ of an admirable museum which formerly constituted the Museum of Irish Industry. It seems probable that what is needed is a removal of the specimens from the College to a suitable building; probably an enlargement of the Royal Dublin Society would be best, and the space thus gained in the College of Science would be invaluable for laboratories. Few of the outside public are aware what a fine collection of mechanical apparatus the late Professor of Mathematics, Dr. Ball, made in the College, and how highly desirable it is that these should be turned to active and good use by his successor.

The Royal Commission on Scientific Instruction and the Advancement of Science have held their final sitting and appended their signatures to the Sixth Report on Science Teaching in Public and Endowed Schools; the Seventh Report on the Universities of London, Scotland, Dublin, and the Queen's University in Ireland; and the Eighth and Final Report on the Advancement of Science and the relations of Government to that branch of study.

For the Paris International Geographical Exhibition an immense number of photographs have been received from the Palestine Exploration Fund, which will afford a good idea of the work done by British explorers. The Russian and Austro-Hungarian Governments have erected, each at its own expense, an elegantly fitted pavilion on the terrace *du bord de l'Eau*, where their exhibits will find ample room. M. Esler, the Danish delegate, has brought with him a complete collection of the dresses used by the natives of Greenland. All the original maps of Paris, from the celebrated tapestry carpet up to the latest published by M. Haussmann, will be exhibited by the French Government. A special section has been arranged for alimentary preparations useful for travelling purposes, and another for inventions relating to salvage.

Session 1875-6 of the Teachers' Classes of St. Thomas Charterhouse School of Science will commence on Sept. 25 next. A public meeting will be held on some Saturday early in October, when an address will be delivered by Dr. Carpenter. The managers of the Gilchrist Trust have made a grant for the delivery of a course of lectures, on alternate Friday evenings, during the session. The arrangements are in the hands of Dr. Carpenter, secretary to the Trust, who is in active communication with Professors Huxley and Tyndall and other eminent lecturers. The lectures will be delivered in the Foresters' Hall, Wilderness Row, near the Charterhouse Schools.

The Committee of the French Association for the Advancement of Science, which meets at Nantes on August 19, have issued invitations and a list of some of the French men of science expected to be present. Among the subjects which will be brought before the Association are Researches on Prussic Acid, by M. Claude Bernard; an important paper by M. Pasteur on Beer; an account of the work relating to the Meridian of France, by Commandant Perrier; and a new rhinoplastic process, by Dr. Ollier. Among those expected to be present are, MM. Dumas, Claude Bernard, Pasteur, H. St. Claire Deville, De Quatrefages, Levasseur, P. Broca, E. Caventou, L. Lefort, E. Moreau, Trélau, Verneuil, and other eminent scientific Frenchmen.

At the half-yearly general meeting of the Scottish Meteorological Society on Tuesday last two interesting papers were read; one on "The Mortality of the Large Towns of the British Islands in relation to Weather," by Mr. Buchan; and the other on "Weather and Epidemics of Scarlet Fever in London during the past thirty-five years," by Dr. Arthur Mitchell. We hope to be able to give a notice of these papers in our next number.

On the 7th of July an extraordinary hail and thunder storm raged over a large part of France, many towns having been deluged in succession. At Geneva, where the phenomenon was more satisfactorily observed than elsewhere, it was found that the hailstones fell on a belt at first only four kilometres in breadth, but enlarging, when near the lake, to about thrice that breadth. The path of these thunderstorms will be investigated by the Meteorological Boards of the different departments, but it will take some time before they are correctly mapped. M. Dumas, at Monday's sitting of the Paris Academy, read a letter from M. Calladon, of Geneva, stating that hailstones of 300 grammes each had been collected; and a letter from M. W. de Fonvielle, describing the icicles observed by M. Duruof on his balloon in his last ascent, about ten days ago. M. Dumas directed the attention of the Academy to the importance of that observation, in order to explain how gigantic hailstones can be generated during abnormal atmospheric perturbations.

There is nothing particularly noteworthy in the Report presented by the Radcliffe Observer to the Board of Trustees on June 29. The work of the Observatory has been steadily pursued, interrupted only by an unusual amount of unfavourable weather. A great advance has been made in the reduction and printing of the observations during the past year.

A lively interest in science seems to have been awakened in Aberdeen, by means of lectures on anatomy and physiology, delivered gratuitously by Prof. Struthers on Saturday evenings in Marischal College. They have been very largely attended by both sexes, and particularly by that portion of the community, comprising all classes, whose opportunities for instruction in scientific subjects have been necessarily restricted. A beautifully illuminated and handsomely mounted address was recently presented to Dr. Struthers by the Dean of Guild of the city on behalf of a large number of subscribers, as a mark of their appreciation of his disinterested labours. The Aberdeen School Board had been stimulated to resolve to introduce some physical science into the Grammar School. They propose to have a course of Elementary Chemistry and Elementary Physics, and also one of Botany. The Mechanics' Institution of Aberdeen, now aided by a munificent bequest from the late Dr. Neil Arnot, himself an Aberdonian, is also doing valuable work in the way of disseminating systematic knowledge in various branches of physical science.

The Halifax Geologists' Field Club now consists of ninety members, and during the past year many papers have been read and a considerable number of excursions made. The president, Mr. J. W. Davis, in his address on May 19, gave an interesting sketch of the work done at the Settle Caves. Mr. L. C. Miall gave a lecture on the 2nd June on the Construction of Geological Maps; and on the 16th, Prof. A. H. Green lectured on the General Structure of the Central Part of Yorkshire Coal Field. The Club seems to be in a healthy condition.

We are glad to see from the "Reports and Proceedings" for 1874 and part of 1875 of the Miners' Association of Cornwall and Devon, which carries on its work to some extent in connection with the Science and Art Department, that notwithstanding the present great depression in mining, this exceedingly useful Association has been able to continue its good work among the class for whose benefit it has been founded. The report of the lecturer, Mr. B. Kitto, F.G.S., is very satisfactory, and is followed by a number of valuable papers on various subjects connected with mining.

The *Revue Scientifique* for July 10 contains M. J. Bertrand's valuable account of the life and work of the late M. Elie de Beaumont, recently read before the Paris Academy of Sciences.

Principal Dawson has sent us an interesting paper, being the Presidential Address to the Natural History Society of Montreal for 1875, entitled "Recollections of Sir Charles Lyell," containing among other things some personal reminiscences of the great geologist's visits to America.

The "Proceedings of the American Academy of Arts and Sciences" for 1874-5 are just to hand; the following is a list of the papers contained in the volume:—Researches on the Hexatomic Compounds of Cobalt, by Wolcott Gibbs, M.D. Contributions to the Botany of North America, by Asa Gray. Graphical Integration, by Edward C. Pickering. On the Solar Motion in Space, by Truman Henry Safford. Historical Sketch of the Generic Names proposed for Butterflies: a contribution to Systematic Nomenclature, by Samuel H. Scudder. On the wide diffusion of Vanadium and its association with Phosphorus in many Rocks, by A. A. Hayes, M.D. Foci of Lenses placed obliquely, by Prof. E. C. Pickering and Dr. Chas. H. Williams. On the Effect of Heat upon the Magnetic Susceptibility of Soft Iron, by H. Amory and F. Minot. A Conspectus of the North American Hydrophyllaceæ, by Asa Gray. Revision of the Genus Ceanothus, and Descriptions of New Plants, with a Synopsis of the Western Species of Silene, by Sereno Watson. List of the Marine Algæ of the United States, with Notes of New and Imperfectly Known Species, by W. G. Farlow. On a New Induction Coil, by John Trowbridge. On the Effect of Armatures on the Magnetic State of Electro-Magnets, by B. O. Peirce and E. B. Levafour. On the Time of Demagnetisation of Soft Iron, by W. C. Hodgkins and J. H. Jennings. Light transmitted by one or more Plates of Glass, by W. W. Jacques. On the Application of Logical Analysis to Multiple Algebra, by C. S. Peirce. On the Uses and Transformations of Linear Algebra, by Benjamin Peirce. On a New Optical Constant, and on a Method of Measuring Refractive Indices without the use of Divided Instruments, by Wolcott Gibbs, M.D. Intensity of Twilight, by Charles H. Williams. Light of the Sky, by W. O. Crosby. Light absorbed by the Atmosphere of the Sun, by E. C. Pickering and D. P. Strange. Tests of a Magneto-electric Machine, by E. C. Pickering and D. P. Strange. Answer to M. Jamin's Objections to Ampère's Theory, by William W. Jacques. Melanosiderite: a New Mineral Species, from Mineral Hill, Delaware County, Pennsylvania, by Josiah P. Cooke, jun. On Two New Varieties of Vermiculites, with a Revision of the other Members of this Group, by Josiah P. Cooke, jun., and F. A. Gooch.

At a meeting of the Council of the Royal School of Mines, held on Saturday, July 3rd, the following gentlemen received the diploma of Associate of the Royal School of Mines:—Mining and Metallurgical Divisions: Harry H. Becher, W. Frecheville, F. H. Marshall, Ambrose R. Willis. Mining Division: Archibald E. Pinching, G. Seymour, H. Lamont Young. Metallurgical Division: G. Fitz Brown, Robert Hellon, W. Foulkes Lowe, Thomas Purdie. Geological Diivsion: G. C. Frames. The following scholarships and prizes were also awarded:—Third-year Students: The De la Beche Medal and prize of books to Mr. G. Fitz Brown; the Murchison Medal and prize of books for Geology to Mr. G. Seymour. Second-year Students: H.R.H. the Duke of Cornwall's Scholarship of 30*l.* for two years to Mr. H. Louis, and the Royal Exhibition of 25*l.* to Mr. W. Hewitt. First-year Students: Two Royal Scholarships of 15*l.* each to Mr. A. N. Pearson and Mr. L. J. Whalley.

During the past week the Commission on Vivisection have held several meetings. The absence of Prof. Huxley is to be regretted.

In the secret committee which was held after Monday's sitting of the Paris Academy of Sciences the claims of M. Mouchez and M. Wolf to the vacant membership in the section of Astronomy were warmly discussed. The election will probably take place next Monday. M. Mouchez is one of the most successful of the Transit observers, and M. Wolf is the sub-director of the Paris Observatory.

A second specimen of a Two-horned Asiatic Rhinoceros was yesterday deposited in the Zoological Society's Gardens. It closely resembles the Hairy-eared species, and does not differ much from the Sumatran animal.

A second edition has been issued of "The Unseen Universe; or, Physical Speculations on a Future State" (Macmillan and Co.)

The Geologists' Association will make a five days' excursion into East Yorkshire, commencing on July 19.

In connection with the calamitous floods around Toulouse, on the 25th June a singular phenomenon was observed at Clermont-sur-Lanquet. The whole of the earth on the slope of a mountain was moved bodily, a shepherd's house being transported uninjured to a distance.

We have received a paper addressed to the Royal Society of Edinburgh by M. F. Lefort, Inspecteur-Général des Ponts et Chaussées, containing Observations relative to Mr. Edward Sang's "Remarks on the Great Logarithmic and Trigonometrical Tables calculated in the Bureau du Cadastre under the direction of Prony." Appended to the paper is Mr. Sang's reply to M. Lefort's observations.

We have received the "Astronomical and Meteorological Observations" made during the year 1872 at the U.S. Naval Observatory.

To those who are interested in the question of the pollution of rivers, we would commend a letter to the Right Hon. G. Sclater-Booth, President of the Local Government Board, entitled "The Pollution of Rivers, by a Polluter" (Mr. E. C. Potter, of Manchester). In a very moderate and reasonable way it advances some arguments in favour of the polluter's side of the question.

The Thirteenth Annual Report of the Birmingham Free Libraries Committee for 1874 is on the whole a satisfactory one. The aggregrate number of issues for the year is 542,887, and although this is only an increase of about 3,000 over 1873, there is a very marked increase in the issues of books to readers in the Reference Library, indicating the growing use of a higher class of works than are deposited in the Lending Library, and showing that the Free Library system is bearing fruit in raising the standard of taste and cultivation among readers. The issue of scientific works both in the Lending and Reference Libraries bears a very fair proportion to that in other departments.

We have received a paper by Mr. W. W. Wagstaffe, of St. Thomas's Hospital, on the mechanical structure of the cancellous tissue of bone, in which the arrangement of the trabeculæ of the articular ends of the human bones are described, from sections, on the same principle as that previously adopted by Mr. F. Ward, Julius Wolff, and others.

The additions to the Zoological Society's Gardens during the past week include a Maholi Galago (*Galago maholi*) from S. Africa, presented by Mr. C. E. Thomson; two Angulated Tortoises (*Chersina angulata*) from S. Africa, presented by Mr. L. A. Knight; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Mr. Alfred Thompson; seven Garganey Teal (*Querquedula circia*), and a Temminck's Tragopan (*Ceriornis temmincki*) from China; two Argus Pheasants (*Argus giganteus*) from Malacca, deposited; two Giant Tortoises (*Testudo indica*) from the Aldabra Islands, purchased; a Malbrouck Monkey (*Cercopithecus cynosurus*) from W. Africa, received in exchange; a Hog Deer (*Cervus porcinus*) and five Chiloe Wigeons (*Mareca chiloensis*) born in the Gardens.

SCIENTIFIC SERIALS

Transactions of the Norfolk and Norwich Naturalists' Society, vol. ii. part i., 1874–5.—This Society has now been in existence for seven years, and at present numbers 140 members. It endeavours, we believe, faithfully to carry out one of the main objects of local societies, the study of the natural history of its district. This number of its Transactions contains the first section, Dicotyledonous, of a list of the flowering plants of Norfolk, forming the sixth instalment of the fauna and flora of the county, which the Society is publishing. Mr. John Quinton also contributes "Notes on the Meteorological Observations recorded at Norwich during 1874." A notable and excellent feature in this Society's publications is the miscellaneous notes, in which are briefly recorded new or interesting facts in the natural history of the county. There are several curious papers in this part. Mr. Amyot gives some details concerning a very old oak at Winfarthing Manor.—Mr. J. H. Gurney communicates some extracts from the notebook of the late Miss Anna Gurney of Northreps, in which she recorded noteworthy zoological occurrences in her neighbourhood, between 1820 and 1856.—A reprint of a letter by Sir J. E. Smith, from vol. vii. of the *Transactions* of the Linnean Society, gives some interesting details concerning several Norwich botanists.—Mr. T. Southwell contributes an analysis of the documents from which the "Indications of Spring," communicated to the Royal Society by Robert Marsham, F.R.S., in 1789, were compiled.—A list of 139 birds observed on the Kimberley estate, by the Earl of Kimberley.—The wild cattle at Chillingham, by Mr. C. G. Barrett, an interesting account of a visit to those rare animals.

Journal of the Franklin Institute, May.—The following are the principal papers in this number: "On the theory of the tension of belts," by Prof. L. G. Franck; the continuation of Mr. C. E. Emery's paper on "Compound and non-compound engines," and of Chief Engineer B. F. Isherwood's paper on "Experiments with different screws;" "On the mechanical equivalent of heat," the translation of a paper by M. Jules Violle. There is also a description of the Centennial Exhibition Buildings, with some excellent views, plans, and elevations.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, May 15.—The first paper describes a new kind of thermometer invented by Dr. Wollny, of Munich, for earth-temperature between 0·3 and 1·8 metres below the surface.—The next is the concluding part of Mr. Colding's article on winds. After explaining the effect of the rotation of the earth on great atmospheric currents, he continues as follows:—Let us consider the case of two winds, a polar and an equatorial, moving side by side in opposite directions, the polar being to the west of the other. Clearly the two will have a tendency to recede from each other, and in consequence there will be rarefaction at their neighbouring borders, producing a reaction in the two currents exactly counterbalancing the force due to rotation. Thus pressure diminishes from their outer towards their inner or neighbouring borders, where there must be a valley or depression of their surfaces. Since the magnitude of this valley depends upon the velocity of the winds, any slackening of velocity in one of them must allow it to break into the other by gravitation, and originate a hurricane revolving against the sun. It is the denser polar wind which generally breaks into the equatorial from a N.W. direction. Condensation of vapour follows, and then under certain conditions a hurricane. Now to take the other case—what will happen if the polar current flows on the east of the equatorial? The effect of the rotation of the earth will be a heaping up or condensation of air at their neighbouring borders, and the heavier current as before will invade the lighter from S.E., bringing rain. Here, however, there can be no hurricane, for gravitation acts dispersively, and the adjustment of level proceeds outwards instead of inwards. If it were possible for a hurricane to arise on the east side of the equatorial current, it would rotate "with the sun." The reason why all hurricanes rotate against the sun is now obvious. With these principles in mind, Mr. Colding thus illustrates the law of Dove: Let us imagine ourselves advancing in a westward direction out of a polar into an equatorial current. The wind turns gradually to E., then it changes to S. and S.W. as we enter the warm current; then we have it W., N.W., N., and finally N.E., in the polar current on the other side. Now at most stations where observations have been made, this direction of shift is the common one. Hence we are led to suppose that the atmosphere as a whole moves sometimes from E. to W., but more commonly from W. to E. There is good reason for this view. If the atmosphere consisted of air only, there would be no reason for an excess of eastward movement, but the equatorial current, more than the polar, carries a large quantity of vapour, and this causes an excess of pressure from W. to E. Therefore, concludes the author, Dove's law is a real law of nature.

June 1.—The chief papers in this number bear the following titles:—"The Climate of the Lower Yenesei," "Co-efficients of Temperature of Naudet's Aneroid," "An empirical demonstration of the Motive Force of the Equatorial Oceanic Current," "Quantity of Carbonic Acid Gas in Desert Air." The last paper refers to an examination of the air of the Libyan desert, by which it appears that the quantity of carbonic acid gas contained by it is about the amount found in other open places.

Reale Istituto Lombardo, Rendiconti, t. 8, fasc. iii., iv., e v.—These parts contain the following papers:—Prof. L. Maggi and G. Cantoni, on some new experiments on heterogeneity and some consequences drawn from previous series of experiments.—On the modification of the pupil observed in some cardialgies, by Dr. A. de Giovauni.—Researches on the morphogeny of alcoholic ferments, by Dr. J. Macagno.—Meteorological observations made at the Observatory of Brera, by Abate G. Capelli.—On some new parasitic fungi found by Dr. A. Cattaneo, of the Cryptogamic Laboratory, on some fruit affected by the so-called rosin disease and gangrene, by Prof. S. Garovaglio; the fungi belonged to the families of *Sporocadus sphæronema*, *Echinobotryum*, and a new kind called *Cattanea*; and the part contains some excellent illustrations of the species.—A note by Prof. C. Combroso on the causes of crime.—On the physiological effects of the *Jaborandus*, a shrub growing in the interior of some provinces of Northern Brazil, and whose leaves much resemble those of laurels, by Dr. Carlo Ambrosoli.—On the correction of temperature in a liquid into which the thermometer cannot be sufficiently immersed, by Prof. Rinaldo Ferrini.—On the centre of gravity in some homogeneous systems, by Prof. G. Bardelli.—Observations of the periodical comet of Winnecke (1819, III.), by Prof. G. V. Schiaparelli, made at the Observatory of Brera.

Freiburg Naturforschende Gesellschaft.—This Society's *Verhandlungen* (vol. vi. Parts I.–III.) contain the following more important papers:—On the action of sulphur chloride upon aniline in the presence of carbon bisulphide, by A. Claus and W. Krall.—On the action of solids upon over-saturated solutions, by F. C. Henrici.—On the occurrence and some reactions of pyrol, by W. Schlebusch.—On the decomposition of grape sugar by cupric oxide in alkaline solution, by A. Claus.—On some volcanic rocks of Java (with plates), by H. Rosenbusch.—On nitrophenylene, by A. Claus.—Microscopic mineralogical researches, by H. Fischer (second paper).—On the galvanic ignition of metal wires, by Dr. J. Müller.—A graphic representation of Ohm's law; notes on melting points; both these papers by the same.—On Diiodohydrine, by A. Claus.—Researches on the Lesser Lamprey (*Petromyzon planery*), by Dr. P. Langerhans (with plates).

THE *Gazzetta Chimica Italiana*, fasc. iv., 1875, contains the following original papers:—On the hydrate of chlorine $Cl_2 + 10H_2O$, by U. Schiff.—On the action of aniline on dichlorhydrine, by the same.—On the supposed transformation of the asparagine of vegetables into an albuminoid, by M. Mercadante.—Besides the above there is a literal translation of Prof. Clerk-Maxwell's paper on the dynamic evidence of the molecular constitution of bodies, as read at the Chemical Society in February last, and a summary of the contents of other journals.

THE "*Annali di Chimica applicata alla Medicina*" (April) contains the following papers:—On chloral-collodion, by C. Pavesi.—On the action of water upon subnitrate of bismuth, by A. Ditte.—On the morphogeny of alcoholic ferments, by Dr. J. Macagno.—On the action of nitrite of amyl upon the blood corpuscles, and on the temperature of the body during the inhalation of this substance, by W. B. Woodmann.—On the origin and propagation of disease (last paper), by Sig. Calton.—On the nature of hydrophobia, by Dr. Brunetti.

Archives des Sciences Physiques et Naturelles, No. 209, May 15.—The following are the principal original papers contained in this number:—On Anæsthetics, by Dr. J. L. Prevost. Reply to that part of M. Marc Micheli's article on the progress of botany in 1874 which concerns plant-motion, by E. Hæckel.

—On the normal spectrum of the sun, the ultra-violet part, by M. A. Cornu, with a plate.

Nachrichten von der Königl. Gesellschaft der Wissenschaften und der G. A. Universität zu Göttingen (Nos. 11–16, 1875).—From these publications we note the following papers:—Researches on the magnetism of steel rods, by Dr. Carl Fromme.—On the oscillations of a magnet under the resisting influence of a copper ball, by Franz Himstert.—On the determination of the specific conducting resistance of gas coal, by Ed. Riecke.—On hyperelliptical integrals, by L. Koenigsberger.—On the irregularities and fundamental numbers of plane curves of the third order with points, by Dr. Hermann Schubert.—On the symmetric functions of weight (XI.), by Prof. Faa de Bruno.—On the volcanic ashes of Turrialba (Costa Rica), by Heinr. O. Lang.—On the structure of German ferns, by H. Conwentz.

Göttingen Royal Society of Sciences.—Nos. 1 to 10 of this society's *Nachrichten* contain the following among other papers: On some cut stones (flints) hitherto unknown, by Fr. Wieseler.—On elastic after effects, by Fr. Kohlrausch.—On Asa Grey's group of *Diapensiaceæ*, by Dr. O. Drude.—On a new genus of Palmæ of the Arecineæ group, called *Grisebachia*, by the same and H. Wendland.—On the proof of Cauchy's theorem for complex functions, by G. Mittag-Leffler.—On the curvature of some planes, by A. Enneper.—On Rabuteau's law of the toxical effect of elements and the action of lithium, by Prof. Husemann.—On a fundamental theme of Plücker's geometry, by Dr. A. Voss.—On the ends of sensitive nerves in the skin, by Prof. F. Merkel.—On dibromobenzoic acids, by A. Burghard.—On iodosulphotoluol, by H. Glassner.—On mononitrobenzonaphtylamides, dinitrobenzonaphtylamide and their derivatives, by P. Ebell.—On *Fucus vesiculosus*, by J. Reinke.—On the action of a weak acid upon the salt of a stronger acid, by H. Hübner and H. Wiesinger.—On magnetism in steel rods, by Herr Fromme.—On the specific resistance of gas-coal, by Herr Schrader.

SOCIETIES AND ACADEMIES

London

Geological Society, June 23.—Mr. John Evans, V.P.R.S., president, in the chair.—Some observations on the Rev. O. Fisher's remarks on Mr. Mallet's theory of volcanic energy, read May 12, 1875, by Robert Mallet, F.R.S. The subject of the Rev. O. Fisher's paper has been anticipated by one from Prof. Hilgard (Geol. Univ. of Michigan) published in the *American Journal of Science* (vol. vii., June 1874). The pith of the Rev. O. Fisher's communication is to a great extent comprised in the two following sentences:—1. That "if crushing the rocks can induce fusion, then the cubes experimented upon ought to have been fused in the crushing?" 2. "If the work (of crushing) is equally distributed throughout, why should not the heat be so also? or if not, what determines the localisation?" In his reply Mr. Mallet controverts the views of the Rev. O. Fisher by bringing them into contact with acknowledged physical laws. He shows that "crushing alone of rocky masses beneath our earth's crust may be sufficient to produce fusion. He also shows that the heat developed by crushing alone cannot be equally diffused throughout the mass crushed, but must be localised, and that the circumstances of this localisation must result in producing a local temperature far greater than that due to crushing. Lastly, he shows that after the highest temperatures have been thus reached, a still further and great exaltation of temperature must arise from detrusive friction and the movements of forcible deformation of the already crushed and heated material." He therefore expresses his conviction that "there is no physical difficulty in the conception involved in his original memoir (Phil. Trans. 1873), but not there enlarged upon in detail, that the temperatures consequent upon crushing the materials of our earth's crust are sufficient locally to bring these into fusion."

On the physical conditions under which the Cambrian and Lower Silurian rocks were probably deposited over the European area, by Mr. Henry Hicks. The author indicates that the base line of the Cambrian rocks is seen everywhere in Europe to rest unconformably upon rocks supposed to be of the age of the Laurentian of Canada, and that the existence of these Pre-Cambrian rocks indicates that large continental areas existed previous to the deposition of the Cambrian rocks. The central line of the Pre-Cambrian European continent would be shown by a line drawn from S.W. to N.E. along the south coast of the English Channel, and continued through Holland and Denmark to the Baltic. Its boundaries were mountainous; they are indicated in the north by the Pre-Cambrian ridges in Pembrokeshire, in the Hebrides and Western Highlands, and by the gneissic rocks of Norway, Sweden, and Lapland. The southern line commenced to the south of Spain, passing along Southern Europe, and terminated probably in some elevated plains in Russia. Between these chains the land formed an undulating plain, sloping gradually to the south-west, its boundary in this direction being probably a line drawn from Spain to a point beyond the British Isles, now marked by the 100-fathom line. The land here facing the Atlantic Ocean would be lowest, and would be first submerged when the slow and regular depression of the Pre-Cambrian land took place. The author points out that the evidence furnished by the Cambrian and Lower Silurian deposits of Europe is in accordance with this hypothesis. In England they attain a thickness of 25,000 to 30,000 feet; in Sweden not more than 1,000 feet; and in Russia they are still thinner, and the earlier deposits seem to be wanting. In Bohemia they occupy an intermediate position as to thickness and order of deposition. The author discusses the phenomena presented by the Welsh deposits of Cambrian and Lower Silurian age, and shows that we have first conglomerates composed of pebbles of the Pre-Cambrian rocks, indicating beach conditions, then ripple-marked sandstones and shallow-water accumulations, and then, after the rather sudden occurrence of a greater depression, finer deposits containing the earliest organisms of this region, which he believes to have immigrated from the deep water of the ocean lying to the south-west. After this the depression was very gradual for a long period, and the deposits were generally formed in shallow water; then came a greater depression, marked by finer beds containing the second fauna; then a period of gradual subsidence, followed by a more decided depression of probably 1,000 feet, the deposits formed in this containing the third or "Menevian" fauna. This depression enabled the water to spread over the area between the south of Prussia and Bohemia and Norway and Sweden, there being no evidence of the presence of the first and second faunas over this area. The filling up of this depression led to the deposition of the shallow-water deposits of the Lingula-Flag group, followed by another sudden depression at the commencement of the Tremadoc epoch, which allowed the water to spread freely over the whole European area. The author next discusses the faunas of the successive epochs, and indicates that these are also in favour of his views. He indicates the probability that the animals, which are all of marine forms, migrated into the European area from some point to the south-west, probably near the equator, where he supposes the earliest types were developed. Both the lower and higher types of invertebrates appear first in the western areas; and the groups in each case as they first appear are those which biologists now recognise as being most nearly allied, and which may have developed from one common type. The lower invertebrates appear at a very much earlier period than the higher in all the areas. In the Welsh area the higher forms (the Gasteropods, Lamellibranchs, and Cephalopods) come in for the first time in Lower Tremadoc rocks; and with the exception of the presence of a Gasteropod in rather lower beds in Spain, this is the earliest evidence of these higher forms having reached the European area. At this time, however, no less than five distinct faunas of lower invertebrates had already appeared; and an enormous period, indicated by the deposition of nearly 15,000 feet of deposits, had elapsed since the first fauna had reached this area. The author points out also that a similar encroachment of the sea and migration of animals in a north-westerly direction occurred in the North American area at about the same time, the lines indicating the European and American depressions meeting in Mid-Atlantic.

On a Bone-cave in Creswell Crags, by the Rev. J. Magens Mello. In this paper the author describes some fissures containing numerous bones, situated in Creswell Crags, a ravine bounded by cliffs of Lower Permian limestone on the north-eastern borders of Derbyshire. These cliffs contain numerous fissures. The principal one described by the author penetrates about fifty yards into the rock, and has a wide opening, but is very narrow throughout the greater part of its length. It runs nearly north and south, and inclines slightly from west to east from the top downwards. The organic remains found in the first fissure belong to fourteen mammals at least, besides a bird and a fish. The mammalia are: Man, *Lepus timidus*, *Gulo luscus*, *Hyæna spelæa*, *Ursus*, sp., *Canis lupus*, *Canis vulpes*, *Canis lagopus*, *Elephas primigenius*, *Equus caballus*, *Rhinoceros ticho-*

rhinus, *Bos urus*, *Cervus megaceros*, *Cervus tarandus*, *Ovis*, sp., *Arvicola*, sp.

Notes on Haytor Iron Mine, by Clement Le Neve Foster, D.Sc.

On the formation of the Polar Ice-cap, by Mr. J. J. Murphy. The present paper is intended by the author to supplement a previous one read before the Society in 1869 (Q. J. G. S., vol. xxv. p. 350), in which he gave reasons for differing from Mr. Croll in thinking that the glacial climate was one of intense cold, and held, on the contrary, that it was one of snowy winters and cold summers, with a small range of temperature. Mr. Campbell, in a paper read before the Society in 1874, gave the following as the southernmost limits of the polar ice-cap, viz. :—In Eastern Europe, lat. 56° N. ; in Germany, 55° ; in Britain, nearly 50° ; in America, 39°. This the author considers as strong but not new evidence against the theory of ice-cap extending to low latitudes ; the extent of the ice-cap would of course not be so wide as that of the limits of glaciation, owing to the floating ice approaching nearer the equator. After commenting on Mr. Belt's remarks made during the discussion of Mr. Campbell's paper, the author states that he attributes the presence of the boulders found in the valley of the Amazon to icebergs which had drifted further than usual. The glaciation of the tropics would imply the glaciation of the whole world, which appears no more possible than that the whole world was submerged at one time. The author concludes with some remarks on a recent paper of Mr. Tylor's.

Notes on the Gasteropoda of the Guelph Formation of Canada, by Prof. H. Alleyne Nicholson, D.Sc., F.R.S.E. The author notices the occurrence of the Guelph formation as a subdivision of the Niagara series in Canada and the United States, and describes it as consisting everywhere of a cellular, yellowish, or cream-coloured dolomitic limestone of rough texture and crystalline aspect, containing innumerable cavities from which fossils of various kinds have been dissolved out. In this paper the author describes all the known Gasteropoda of the Guelph formation in Canada, including the following previously described species :—*Murchisonia Loganii* (Hall), *M. turritiformis* (Hall), *M. macrospira* (Hall), *M. bivittata* (Hall), *M. longispira* (Hall), *M. vitellia* (Billings), *M. Hercyna* (Billings), *Cyclonema ? elevata* (Hall), *Holopea guelphensis* (Billings), *H. gracia* (Billings), *Subulites ventricosus* (Hall), and *Pleurotomaria solarioides* (Hall). As new species he describes *Murchisonia Boylei*, distinguished from *M. turritiformis* (Hall) and *M. estella* (Billings) by its more rapid rate of expansion, its apparently canaliculated suture, and the existence of an angular band a little above the suture ; and *Holopea ? occidentalis*, distinguished by its short but elevated spire, its large body-whorl, which becomes almost disjunct at the aperture, its circular aperture, and large umbilicus. The upper whorls are convex, but the body-whorl is obtusely angulated at about its upper fourth. Uncertain species of *Murchisonia* and *Pleurotomaria* are also indicated.

Description of a new genus of Tabulate Coral, by Mr. G. J. Hinde. The coral described by the author as constituting a new genus of Favositidæ, for which he proposes the name of *Sphærolites*, has a massive free corallum consisting of minute, polygonal, closely united corallites, growing in all directions from a central point, forming a spheroidal body, the entire surface of which is occupied by the calices of the corallites. The walls of the corallites are very delicate, with numerous pores ; the tabulæ are incomplete, formed by delicate arched lamellæ, and there are no septa. From *Chætetes* this genus is distinguished by the perforated walls and incomplete arched tabulæ ; from *Favosites* it differs in its mode of growth and its incomplete tabulæ ; and from *Michelinia* it is separated by the minuteness of its corallites, and the absence of epitheca and of septal striæ. The single species, which is named *S. Nicholsoni*, is from calcareous shale of Lower Helderberg (Ludlow) age, near Dalhousie, in New Brunswick.—(*To be continued.*)

Physical Society, June 26 (continued from p. 179).—Prof. G. C. Foster, vice-president, in the chair.—Prof. G. C. Foster called attention to the work of Prof. Everett on the Centimetre-gramme-second (C.G.S.) System of Units which will shortly be published by the Society. It is designed to facilitate the study of the quantitative relations between the different departments of physical science by the adoption of a common system of units. Prof. Foster explained that a committee of the British Association which was appointed in 1872, and of which Prof. Everett was secretary, recommended the adoption of this system, based upon the metric system, the unit of *mass* being the gramme, that of *length* the centimetre, and that of *time* the second. They recommended that the unit of force be called a *dyne*, which therefore is the force required to act upon a gramme of matter for a second to generate a velocity of a centimetre per second. The unit of work is called an *erg*, and is the amount of work done by a dyne working through the distance of a centimetre. Prof. Everett's book consists of a collection of physical data reduced to these fundamental terms, so that no other physical magnitudes enter into the expressions, and it cannot fail to prove of the greatest possible value to physicists. Prof. Foster then left the chair, which was taken by Dr. Stone.—Dr. W. .M Watts communicated a paper on a new form of micrometer for use in spectroscopic analysis. In determining the positions of lines in a spectrum by the use of a micrometer eye-piece or divided arc, it is often difficult to see the cross wires distinctly without admitting extraneous light, which with faint spectra frequently cannot be done. Dr. Watts has sought to overcome this difficulty by substituting some one known line of the spectrum itself for the cross wires, and to measure the positions of unknown lines by bringing this index line successively into coincidence with them. Thus, for example, the sodium line, which is present in nearly every spectrum whether it is wanted or not, may be made to move slowly when under the spectrum, and the displacement necessary to make it coincide with the lines to be measured may be determined by the readings of a micrometer screw. To accomplish this a convex lens of about two-feet focus is placed in front of the prism of the spectroscope, between the prism and observing telescope, and is divided along a line at right-angles to the refracting edge of the prism. One half of the lens is fixed, the other half is made to slide over it by means of a micrometer screw. When the movable half of the lens is in its normal position, the only effect is to alter the focus of the telescope slightly, but when it is made to slide over the fixed half, the refraction of the prism is increased or diminished, and half of the spectrum appears to move over the other half, and the sodium line, or any other convenient line of reference can be brought into coincidence with the lines to be measured. The indications of this instrument are reduced to wave-lengths by means of a series of interpolation curves from the data obtained by observations of the solar spectrum, the coordinates of which are wave-lengths and micrometer readings. The author considers the advantages of the instrument to be (1) great precision in results ; and (2) convenience in use. In illustration of the former quality he quotes twenty readings of the point at which there is coincidence of the lenses. They are remarkably concordant, the mean being 8·34, while the two extreme readings are 8·21 and 8·41.—Prof. Guthrie then read a paper on the fundamental water-waves in cylindrical vessels. He stated that many attempts had been made to connect wave-lengths with wave-amplitude, and that the most successful of these were by the brothers Weber, who allowed a column of water to fall into one end of a long trough filled with water ; and they ascertained by means of a stopwatch when the crest of the wave reached the other end. Dr. Guthrie has recently made some experiments on this subject, in which he employed a series of five vessels, varying in diameter from 5·5 to 23·5 inches. The water in each was agitated in the centre by a disc of wood, by which means the vessel was made to give what Dr. Guthrie called its "fundamental note." He counted the number of times the wave rose in the centre in a minute, and he found that amplitude has no influence upon the rate. It should also be observed that the wave effect is not the same as if the field were of infinite extent. The following are the results he obtained :—

	Diameter of vessel.	No. of pulsations per minute.
(1)	23·5 inches.	... ... 106·5
(2)	17·87 "	... ... 122·7
(3)	14·5 "	... ... 136·0
(4)	12·5 "	... ... 146·5
(5)	5·5 "	... ... 219·0

From which he deduced the curious result that a constant quantity (517·5) is obtained by multiplying the square root of the diameter by the number of pulsations. The question of depth was also carefully considered, and it was ascertained that the number of waves increases slightly with the depth.—Mr. S. C. Tisley read a paper on a new form of magneto-electric machine. After briefly describing the machines which have hitherto been devised, he stated that the new apparatus consists essentially of an electro-magnet with shoes forming a groove, in which a Siemens' armature is made to revolve. It differs from the original machines made by Siemens and Wheatstone in the commutator, as two springs conduct the current from the cylindrical insulator, to which are attached three pieces of metal, one surrounding it for three-quarters of its circumference, the second for one quarter, and between these is a ring connected with the insulated end of the wire from the armature, and bearing two pieces of metal which are so arranged as to complete the circles of the outer pieces of metal. The armature is so constructed that a stream of water may be constantly passed through it. A small machine constructed on this principle, which without its driving gear weighs 26 lbs., is capable of raising 8 inches of platinum wire 8 inches long and ·005 inches in diameter to a red heat.—Dr. Stone then adjourned the meetings of the Society until November.

VIENNA

Imperial Academy of Sciences, Jan. 14.—The following papers were read:—On the temperatures arising from the mixing of sulphuric acid with water, with reference to the molecular heats and boiling points of the resulting hydrates, by Dr. L. Pfaundler.—On the occurrence of relatively high temperatures of air in the valleys of the Alps, by Prof. Kerner.—On some researches on dinitro compounds of the phenyl series, by Prof. Hlasiwetz. The author shows that phenol can easily be converted into dinitrophenol if treated with nitrous acid when dissolved in ether. At the same time mononitrophenol is formed—

(1) $C_6H_5.OH + N_2O_3 = C_6H_4N_2O + N_2O_5 + H_2O$
(2) $2C_6H_5.OH + N_2O_5 = 2C_6H_4.NO_2.OH + H_2O$.

—Prof. Weiss then gave an account of his observations of the transit of Venus at Jassy. The inner contact could not be observed through clouds, but the outer one was observed at 20h. 25m. 49s·7 Jassy mean time. Prof. Weiss thinks that through the unsatisfactory state of the atmosphere this result may probably not be quite correct, and that the actual contact took place a few tenths of a second later. The longitude of the observing station was found to be 44m. 49s.·7 east of the Imperial Observatory of Vienna (probable error in this = ± 0s·1).—Prof. Oppolzer gave an account of his observations at the same place, and quoted his results in Paris mean time. In the reports of the Academy for April 1870 he had given the time for the second outer contact 18h. 45m. 25s.·7 Paris mean time; he found by observation 18h. 44m. 56s.·3 Paris mean time; difference, 29s.·4. The latitude of Jassy is given as + 47° 9′ 25″·1 (± 0″·2).

Jan. 21.—The following papers were read:—A note on the experimental determination of diamagnetism by means of its electric action of induction, by Prof. Toepler.—On the action of the muscular current upon a secondary circle of currents, and on a peculiarity of currents of induction, induced by a very weak primary current; by Prof. Brücke.—On some *Acara* and *Geophagus* species of the Amazon River, by Dr. Steindachner; in a second paper this gentleman spoke of four new Brazilian siluroids, belonging to *Oxydoras*, *Doras*, and *Rhinodoras*.

Feb. 4.—On the double refraction of quartz under pressure, by Prof. Mach.—On the latent heat of vapours, by Prof. Puschl.—On the fine structure of bones, by Prof. v. Ebner.—Detailed classification of all known Foraminifera, by A. v. Reuss.—Researches on the development of Naiades (freshwater mussels), by W. Flemming.—On the dependence of the coefficient of friction of the air upon temperature, by A. v. Obermayer.

Feb. 18.—On phenomena of flexion in the spectrum, by W. Rosicky.—On the temperatures of solidification of the hydrates of sulphuric acid and the composition of the crystals formed, by Prof. Pfaundler and E. Schnegg.

Feb. 25.—On the Tertiary strata on the north side of the Apennines from Ancona to Bologna, and on the Pliocene formations of Syracuse and Lentini, by Th. Fuchs and A. Bittner.

March 11.—On the great ice period, and on some geological theories, by Dr. A. Boué.—On anthracene and its behaviour towards iodine and mercuric oxide, by Dr. H. Hlasiwetz and Dr. O. Zeidler.

March 18.—On a consequence drawn from Biot-Savart's law, by Prof. A. Wassmuth.—On the thermoelectric behaviour of metals during melting and solidification, by A. v. Obermayer.

STOCKHOLM

Kongl. Vetenskaps Akademiens Förhandlingar, Jan. 13.—The following papers were read:—On the relation of temperature and moisture in the lowest strata of the atmosphere at daybreak, by R. Rubenson.—On the efflorescence of alum salts and their influence on vegetation, by C. E. Bergstrand.—On the conduction of heat in a cylinder, by G. Lundquist.—On the situation of moraines and terraces on the banks of many inland lakes, by A. Helland (with plate).—*Insecta Transvaalensia*, a contribution to the insect fauna of the Transvaal Republic, South Africa, by H. D. J. Wallengren.—On the low vegetation of Omberg, by P. G. E. Theorin. These papers are all in Swedish, with the exception of that by A. Helland, which is in the Danish language.

PARIS

Academy of Sciences, July 5.—M. Frémy in the chair.—The following papers were read:—A note by M. Chevreul, on the explanation of numerous phenomena which are a consequence of old age. This is the abstract of a third memoir on the subject.—On the distribution of magnetism in bundles of an infinite length composed of very thin laminæ, by M. J. Jamin.—Second note on tabular electro-magnets with multiple cores, by M. T. du Moncel.—The rain of Montpelier during twenty-three years (1852–74), from observations at the Jardin des Plantes, by M. Ch. Martins.—On the Devonian period in the Pyrenees, by M. A. Leymerie.—A letter was read from P. Secchi, accompanying the presentation of the second French edition of his work on the Sun.—Description of the group of the Pleiades and micrometric measurements of the positions of the principal stars which compose it, by M. Wolf. The author employed an object-glass of 0·31m. aperture, the positions being given to one-tenth of a minute of arc. The catalogue comprises 499 stars from the 3rd to the 14th magnitude, contained in a rectangle 135 min. long, and 90 min. broad, η Tauri occupying the centre. All the stars in the group are referable to P. Secchi's first type with regard to their spectra. The differences between the author's measurements and those of Bessel seem to point to the conclusion that the group has a proper motion towards the north-west.—Researches on carbon monosulphide, by M. Sidot. According to the author, this substance is formed by the prolonged action of light on carbon disulphide. It is described as a reddish brown powder possessing neither taste nor smell. Analyses gave numbers agreeing with the required formula CS.—On atmospheric currents, by M. J. A. Broun.—Phylloxera in the Department of Gironde, by M. Azam.—Planet 146 Lucine. Elements of the orbit calculated, by M. E. Stéphan.—On the processes of magnetisation, by M. J. M. Gaugain.—The nut from Bancoul. Chemical studies of the oleaginous fruits of tropical countries, by M. B. Corenwinder.—On the gum in wine and its influence on the determination of the glucose, by M. G. Chancel.—Chlorobrominated ethylene: isomerism of its chloride and the bromide of perchlorinated ethylene, by M. E. Bourgoin.—Influence of chalk on the distribution of the so-called "calcifuge" plants, by M. C. Contejean.—On the absorption of coloured liquids, by M. Cauvet.

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THURSDAY, JULY 22, 1875

THE LIFE OF LANGUAGE

The Life and Growth of Language. By William Dwight Whitney, Professor of Sanskrit and Comparative Philology in Yale College. The "International Scientific Series," vol. xvi. (London: King and Co., 1875.)

THIS is certainly a disappointing volume. When the editors of the *International Scientific Series* offered us a treatise on Language by the side of such works as Tyndall's "Forms of Water in Clouds and Rivers," Bagehot's "Physics and Politics," Bain's "Mind and Body," Spencer's "Study of Sociology," we had a right to expect something substantial, if not original. Instead of this, Prof. Whitney presents us with what is to all intents and purposes an abstract of his "Lectures on the Study of Language," delivered in 1864 in Washington and other places, lectures which in themselves contained hardly more than a popular summary of some of the results obtained by the researches of German, French, and English scholars on the origin, the development, and the classification of languages. "The old story," to let Prof. Whitney speak for himself, "is told in a new way, under changed aspects and with changed proportions, and with considerably less fullness of exposition and illustration." But why simply tell us the old story over again? Has the science of language made no progress since 1864? Has Prof. Whitney himself worked up no new materials? Has he no discovery of his own to record in his own special fields of labour? Has he brought none of the problems which, as he told us in 1864, still perplexed the students of the science of language, nearer to a solution? Or, at all events, has he not found some more felicitous illustrations than those with which he entertained his hearers ten years ago? If any one who knows the Professor's lectures, should read his new treatise on what he strangely calls the "Life and Growth of Language," we doubt not which of the two volumes he will keep on the shelves of his library, and which he will assign to the corner of ephemeral literature. Prof. Whitney has set forth his good wine at the beginning, and gives us now that which is worse. To judge from other numbers of the *International Series*, the rules imposed on the contributors do not seem to have prevented them from treating their subjects in a thorough, if not in an exhaustive way. Besides, there are in this volume several lengthy discussions as to whether the science of language should be called a physical or an historical science, whether it deserves the name of a science at all, whether a knowledge of psychology is essential to the student of language or not; discussions which, as far as we are able to judge, contain an "infinite deal of nothing," and add very little to what had already been written on these subjects.

In one respect, however, we have to congratulate Prof. Whitney most warmly on a great improvement in these his second and more sober thoughts. From beginning to end his new book is free from spite and personal invective. Neither Humboldt, nor Bopp, nor Renan, nor Schleicher, nor Bleeck, nor Steinthal, nor Goldstücker are held up to ridicule as ignorant of the A B C of grammar and logic. There is here and there a groundswell and a distant rumble, but on the whole the sea is between moderate and smooth, and we arrive at Calais with a feeling of relief and sincere thankfulness. It may be that these feelings are not shared by all readers. Man is by nature a pugnacious animal, and though in later life but few like to use the cudgels themselves, they still like to look on where there is a row. Prof. Whitney's new book therefore may seem to some people more dull than any of his former compositions; yet his true friends will rejoice that for once he has chosen the better part of valour, and in showing regard to others has shown respect for himself.

In making this laudable effort, however, Prof. Whitney seems to us to have fallen, involuntarily, no doubt, into a mistake which we hope he will forgive us for pointing out. Prof. Whitney, it is true, has not in this volume, as far as we can trust our memory, abused anybody by name. He himself takes credit for it at the end of his preface, where he says: "I have on principle avoided anything bearing the aspect of a personal controversy." But neither has he thought it necessary to add any references where he avails himself of the work done by other scholars. On this point, too, we shall quote his own words:—"And I have had to leave the text almost wholly without references, although I may here again allege the compendious cast of the work, which renders them little called for. I trust that no injustice will be found to have been done to any. The foundation of my discussion is (*sic*) the now generally accessible facts of language, which are no man's property more than another's."

This is not the first time that Prof. Whitney makes these curious excuses. In the preface to his Lectures the same or a very similar plea was put forth. We quote again his *ipsissima verba*:—"The principal facts upon which my reasonings are founded have been for some time past the commonplaces of comparative philology, and it was needless to refer for them to any particular authorities. When I have consciously taken results recently won by an individual, and to be regarded as his property, I have been careful to acknowledge it. It is, however, my duty and my pleasure here to confess my special obligations to those eminent masters in linguistic science, Professors Heinrich Steinthal, of Berlin, and August Schleicher, of Jena, whose works I have had constantly upon my table, and have freely consulted, deriving from them great instruction and enlightenment, even when I have been obliged to differ most strongly from some of their theoretical views. Upon them I have been dependent, above all, in preparing my eighth and ninth lectures; my independent acquaintance with the languages of various type throughout the world being far from sufficient to enable me to describe them at first hand. I have also borrowed here and there an illustration from the 'Lectures on the Science of Language' of Prof. Max Müller, which are especially rich in such material."

Now, what we wish to point out with reference to these repeated reservations on the part of Prof. Whitney is this. Because an author refrains from personal invective, it does not seem to us to follow that he may also dispense with giving honour where honour is due. No doubt there are a good many facts in the science of language which by this time have become public property, nay, where it would be extremely difficult to say who was their original discoverer. That Sanskrit *asti* is the same as Latin *est*, that Sanskrit *trayas* coincided with Latin *tres*, was probably seen by every scholar who ever opened a Sanskrit grammar. In such cases it can be merely a matter of historical interest to find out who was the first lucky observer. It seems to us one of the chief merits, for instance, of Curtius's Principles of Greek Etymology, that he tells us in most cases, with the greatest conscientiousness, who were the scholars that first proposed or afterwards defended and substantiated the etymology of different words. Such references involved, no doubt, considerable trouble, and we have no right to expect in a popular work the same learned *apparatus*. But there are limits here as everywhere else, which no one can overstep with impunity. Every writer, unless his memory is growing weak, knows perfectly well what comes out of his brain, and what comes out of his pockets; what he has found out himself by dint of hard work, and what he has simply borrowed from others. A large array of footnotes and references may be in many cases a mere pedantic display of learning, but to omit all indications of sources and authorities is hardly defensible, nor can it be excused on the ground of "the compendious cast" in a book where we find, on the second page, references to two of Prof. Whitney's own writings. This is really not a matter of sentiment only, but a matter of serious import in the world of letters. Dates are easily forgotten, and of late it has happened several times that one writer has actually been blamed for having borrowed from another without acknowledgment, whereas he was the creditor and the other the debtor. This leads to awkward explanations, sometimes to angry controversies, all of which can be avoided by a frank compliance with rules long recognised in the republic of letters.

If we confine ourselves to some of the principal subjects treated in Prof. Whitney's new work, would it not have been interesting to know who first pointed out the two motive powers in the growth of language on which Prof. Whitney dwells so largely—*Phonetic Decay*, and *Dialectic Growth* or *Variation?*

Again, when an intelligible and sufficient cause was wanted for what was vaguely and metaphorically called Phonetic Decay, who was it that first ventured to suggest that there was nothing mysterious in that process, and that it could be explained in a very homely way as the result of laziness, or of economy of muscular energy?

There is one question which Prof. Whitney has treated more fully in this than in his former work, viz., the true meaning of dialect, and the relation between dialects and languages. He exhibits most ably the inevitability of dialectic variety in the very beginning of human speech, and the gradual elimination of dialectic forms in the later growth of language. Were there not others who had strongly insisted on the dialectic nature inherent in language, and had borne the brunt of the battle against numerous unbelievers?

We still remember the time when the leading philologists in Germany protested against the introduction of scientific Phonetics into Comparative Philology. If at present phonetic and physiological discussions form the introduction and groundwork to every treatise on Comparative Philology, is it not well to remember the names of those who were once ridiculed as the founders of the *Fonetik Nuz?*

It may be, as Prof. Whitney asserts, that though Germany is the home of Comparative Philology, the scholars of that country have distinguished themselves much less in that which *We* have called the Science of Language. It may be easy, as he says in another place, to note remarkable examples of men of the present generation, enjoying high distinction as comparative philologists, who, as soon as they attempt to reason on the wider truths of linguistic science, fall into incongruities and absurdities. But who were the first to conceive a Science of Language as different from Comparative Philology, though beholden to it for its most valuable materials? Who first drew the outlines of that science, collected the facts required for its illustration, and established the leading principles for its study? Prof. Whitney could have answered all these questions better than anybody else, whereas, by his reticence, he may now leave on many of his readers the impression, though no doubt very much against his own will, that the science of language had its cradle in America, and that German, English, and French scholars have added nothing to it, except "incongruities and absurdities."

After having made these reservations in favour of the founders of and former contributors to the science of language, let us now see in what Prof. Whitney's own contributions to that science consist. We shall have no difficulty in doing this, for he tells us frequently in the course of his writings what he himself has done for rescuing the science of language from the "incongruities and absurdities" of European scholars.

His first discovery is that *Language is an Institution.* No one, we believe, would feel inclined to controvert this statement. Language is an institution, and a most excellent institution.

We therefore pass on to the next discovery, which is that *Language is an Instrument.* This again is not a very startling assertion. It is well known that Plato, in trying to find out in his own Socratic method what language is, begins with the same assertion.

"*Soc.* That which has to be cut has to be cut with something?

"*Her.* Yes.

"*Soc.* And that which has to be woven or pierced has to be woven or pierced with something?

"*Her.* Certainly.

"*Soc.* And that which has to be named has to be named with something?

"*Her.* That is true.

"*Soc.* What is that with which we pierce?

"*Her.* An awl.

"*Soc.* And with which we weave?

"*Her.* A shuttle.

"*Soc.* And with which we name?

"*Her.* A name.

"*Soc.* Very good. Then a name is an instrument."

The only difference between Plato and Prof. Whitney is this, that with Plato this crude definition is but the first link in a long chain of argument, a proposition made simply in order to show its insufficiency; while Prof. Whitney seems to look upon it as free from all objections.

The third discovery which Prof. Whitney considers as peculiarly his own is, that *everybody learns his language from his parents.* While other writers on the origin of language have "aimlessly expended a surprising amount of sapient philosophy," Prof. Whitney solves the whole question on the first page. We must again quote his own words:—

> "There can be asked, respecting language, no other question of a more elementary and at the same time of a more fundamentally important character than this: How is language obtained by us? how does each speaking individual become possessed of his speech? Its true answer involves and determines well-nigh the whole of linguistic philosophy. There are probably few who would not at once reply that we learn our language; it is taught us by those among whom our lot is cast in childhood. And this obvious and common-sense answer is also, as we shall find on a more careful and considerate inquiry, the correct one."

This third discovery, too, will hardly meet with any objections. Prof. Whitney says, indeed, that two different answers are conceivable, viz., that language is inherited as a race-character, like colour, or that it is independently produced by each individual; but though we do not deny the conceivableness of such propositions, we doubt whether any being endowed with the gift of language ever made them, and whether they required "the crushing weight of facts" which Prof. Whitney brings out against them. We do not blame an author, who for argument's sake sets up what in German is called a *Strohmann*, in Sanskrit a *Púrvapaksha;* but when we read on p. 145, "There are those still who hold that words get themselves attributed to things by a kind of mysterious natural process, in which we have no part; that there are organic forces in speech itself, which by fermentation, or digestion, or crystallisation, or something of the sort, produce new material and alter old," Prof. Whitney would appear to have allowed himself to be carried away a little too far by his dramatic imagination.

To most people, however, be they scholars or philosophers, it would seem that to be told that a child learns his language from his mother, does not help them very much towards a real insight into the origin of language. We should go on from child to mother, from mother to grandmother, and so forth, but this retrogression *in infinitum* would land us exactly at the same point from which we started, viz., How did the first mother get her language? Let us hear what Prof. Whitney has to say in answer to this ever-recurring question. He tells us to look around us and to see what takes place at present. Thus, after explaining the recent discovery of a new tar colour, which by its discoverer was called *magenta*, he says:—"The word *magenta* is just as real and legitimate a part of the English language as *green*, though vastly younger and less important; and those who acquire and use the latter do so in precisely the same manner as the former, and generally with equal ignorance and unconcern as to its origin." And again, after referring to the wholly arbitrary formation of the word *gas* by Van Helmont in A.D. 1600, Prof. Whitney writes:—"We cannot follow so clearly toward or to its source the word *green*, because it is vastly older; but we do seem to arrive by inference at a connection of it with our word *grow*, and at seeing that a *green* thing was named from its being a *growing* thing; and this is a matter of no small interest as bearing on the history of the word."

Here then we have arrived at last at what Prof. Whitney would call the *pivotal* fact. The word *green* and all other words were made in the same way in which Van Helmont made the word *gas*, and the inventor of aniline colours the word *magenta*. *Green* was made from *to grow*. But, as we ventured to ask before in the case of the child, the mother, and the grandmother, would it be impertinent to ask what *to grow* was made from?

We have endeavoured to give as full an account as possible of what Prof. Whitney offers us as his own science of language, free from all the "incongruities and absurdities" of German scholars. If we have left out some facts on which he himself may lay great stress, and which he may consider as his own discoveries, we have done so from no unkind motive. He dwells, for instance, very strongly on the fact that men speak because they wish to communicate, a theory which again will hardly rouse violent opposition. However, in order to be quite just, we shall once more quote the professor's *ipsissima verba*:—

> "Nor is it less plain what inaugurates the conversion and becomes the main determining element in the whole history of production of speech; it is the desire of communication. This turns the instinctive into the intentional. As itself becomes more distinct and conscious, it lifts expression of all kinds above its natural basis, and makes it an instrumentality; capable, as such, of indefinite extension and improvement. He who (as many do) leaves this force out of account, cannot but make utter shipwreck of his whole linguistic philosophy."

We should think he would. We only question whether anybody was ever ignorant of the fact that speech was meant for speaking.

On all the points hitherto mentioned, which Prof. Whitney considers as fundamental or pivotal in his Philosophy of Language, there can be little difference of opinion, nor will they excite much alarm among scholars or philosophers. There are, however, some other points of real interest and importance where we should have been extremely grateful to Prof. Whitney if he had given us not only his opinions, but the ground on which these opinions are based. It is well known that most scholars count the Mongol language as a member of the Ural-Altaic family. Prof. Whitney excludes Mongolic and Tungusic, not on linguistic, but on ethnological grounds, from that family which he calls the Scythian, a name, as Prof. Pott has already remarked, "more nebulous than Turanian." He assures us that it is not undue scepticism that leads him to limit the Scythian family for the present to its demonstrated branches, but that in this direction there has been such an excess of unscientific and wholesale grouping, the classification of ignorance, that a little even of overstrained conservatism ought to have a wholesome effect. If one considers that this reproof is administered to scholars, such as Castren, Schott, and Boller, who have devoted the whole of their lives to the study of these Turanian dialects, one cannot but look forward with the deepest interest to the publication of the results of Prof. Whitney's own studies in Mongol and Mandshu. But while we admire his conservatism on this question, we are still more struck by the boldness with which he decides questions on which the most competent scholars have hitherto spoken with great hesitation, arising not from sentiment, whether conservative or liberal, but from a thorough appreciation of the weight of conflicting evidence. Crawfurd and others notwithstanding, Prof. Whitney assures us that the Malayan, the Polynesian, and the Melanesian languages may henceforth be safely treated as one family, as more closely related, therefore, than Mongolic and Tartaric. One more instance. The Annamese or Cochin Chinese, the Siamese, and the Burmese, whatever their differences, are all alike, we are told, in the capital point, that they are uninflected, and this cannot but be regarded as a strong indication of ultimate relationship. Provisionally, therefore, they are to be classed together as the South-eastern Asiatic, or Monosyllabic Family. All we can say at present is that we hope this is the classification of knowledge, and not of ignorance, and that we shall soon have the *pièces justificatives*, particularly with regard to the Burmese and Siamese. Some new light may also be expected from Prof. Whitney with regard to Chinese, the literature of which, we are told, goes back to 2000 B.C., whatever sceptics may say to the contrary. On all these points our expectations are raised to the highest pitch, and we hope that the professor will soon find leisure to give us not only his conclusions, but the facts on which they are founded. As we said in the beginning, we are disappointed by his present book; we are quite willing, however, to look upon it as a promise, and we have no doubt that the American scholar will soon redeem the pledges which he has given, and thus not only relieve the science of language from "the incongruities and absurdities" of English, German, and French scholars, but enrich it by truly original American discoveries.

We may point out a few of the inaccuracies as to matters of fact which struck us in the Professor's new book.

Prof. Whitney thinks that *green* may be derived from *to grow*. Is not the root really HAR, and the transition of meaning, to be bright, to be green, to grow (grünen)? See Curtius, *s.v.* χλόη.

Agra, as a Sanskrit word corresponding to ἀγρός, is probably a misprint only. The true Sanskrit word is *Ajra*, field, with the palatal media, whereas *agra* means point.

The nasals are not formed by exit through the nose (p. 63); on the contrary the more we shut the nostrils the more nasal becomes our pronunciation. One of the earliest phoneticians, De Brosses (1709–1778), remarked very truly: "On s'exprime à contre-sens, quand on dit, *parler du nez;* c'est une espèce d'antiphrase: on parlerait du nez si on n'en avait point. S'il est bouché, si l'air n'y passe pas librement, on parlera, on chantera du nez."

The derivation of *luna* from *lucna* (p. 83) is no longer tenable, because we have to take into account the dialectic form *losna*, presupposing an original *loux-na* as in *illustris* for *inluxtris*.

On p. 215, in discussing words like *brother* and *sister*, *bull* and *cow*, *ram* and *ewe*, Prof. Whitney says: "*Man* in its distinctive sense indicates a male animal, and we have a different word, *woman*, for a female of the same kind." The choice of the illustration is not quite happy, considering that *woman*, as is well known to Prof. Whitney, is only a corruption of *wîf-man*.

M. M.

DARWIN ON CARNIVOROUS PLANTS *

II.

Insectivorous Plants. By Charles Darwin, M.A., F.R.S., &c. With Illustrations. (London: J. Murray, 1875.)

IN the Venus's Fly-trap, *Dionæa muscipula* (Fig. 5), we have a further differentiation of the organs of assimilation. The sensibility or irritability resides in three hairs—termed by Mr. Darwin "filaments"—on each half of the upper surface of the bilateral leaf; while the function of absorption appears to belong only to a number of small purplish almost sessile glands which thickly cover the whole of the upper face. These glands have also the power of secretion; but only—and here we have another variation from *Drosera*—when excited by the absorption of nitrogenous matter. The filaments are sensitive both to sudden impact and to contact with other substances, except water; the lobes of the leaf closing together, in the former case very suddenly, in the latter more slowly. If the leaf has closed in consequence of sudden impact or of the contact of non-nitrogenous matter, the two lobes remain concave, enclosing a considerable cavity; shortly re-open in perhaps twenty-four hours; and are at once again irritable. When, however, the irritating foreign substance contains soluble nitrogenous matter, the lobes of the leaf become gradually pressed closely together, and remain closed for a period of many (from nine to twenty-four) days; and when they again open, if they ever do so, are at first scarcely sensitive to renewed irritation. The mode in which (as Mr. Darwin shows) this arrangement is serviceable to the plant by securing the capture of large and permitting the escape of small insects, is highly curious, but too long to quote. The absorption of nitrogenous matter by the glands is accompanied by an aggregation of the protoplasm in the cells of the filaments, similar to that observed in *Drosera*, but this result does not follow the simple irritation of the filaments. The series of experiments described appears to prove the existence of an actual process of digestion in *Dionæa*, the closed leaf forming a temporary stomach, within which the acid secretion is poured out. The plant seems to be subject to dyspepsia, which is even fatal when it has indulged too freely in the pleasures of the table, or rather of the leaf. These observations, however, come from America, where, in its native land, its habits may possibly be more intemperate than in this country. Mr. Darwin believes the motor impulse to be transmitted in *Dionæa* as in *Drosera*, through the parenchymatous tissue of the leaf.

Aldrovanda, an aquatic, perfectly rootless genus, also belonging to the order Droseraceæ, presents phenomena similar to those of *Dionæa*, possessing sensitive hairs which cause the leaf to close, and glands which secrete a digestive fluid and afterwards absorb the digested matter. The order embraces, in addition, only three other genera, *Drosophyllum*, *Roridula*, and *Byblis*, all of which are provided with secreting glands, possessed, in all probability, of similar properties.

When the painful rumour gained circulation, not many months ago, that *Pinguicula* must be added to the list of predatory plants, it was received with even greater incredulity than the stories about *Drosera*. The facts are, however, as patent as in the plants already described.

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* Continued from p. 209.

We have here no sensitive hairs, as in the Droseraceæ. The upper surface of the leaf is studded with glandular hairs of two kinds, one with longish stalks, the other nearly sessile, both of which secrete an extremely viscid fluid; and the dull irritability resides in the blade of the leaf itself, which becomes slowly incurved at the margins over substances that excite its sensibility (Fig. 6). This movement of the margin of the leaves (not the apex) is caused either by continued pressure from a foreign solid substance, or by the absorption of nitrogenous matter; water or a solution of sugar or gum produces no curvature; and although the latter, if sufficiently dense, excite a copious increased flow of the viscid secretion, this has no acid reaction. The increased secretion, occasioned by contact of nitrogenous solids or liquids with the glands, is, on the contrary, invariably acid, and possesses the power of rapidly dissolving and digesting insects and other nutrient substances. Some vegetable substances containing nitrogen, as some seeds and pollen-grains, are acted on in a similar manner, so that the butterwort is a vegetable as well as an animal feeder. The secretion appears to be again absorbed into the glands, together with the nutrient substance dissolved in it.

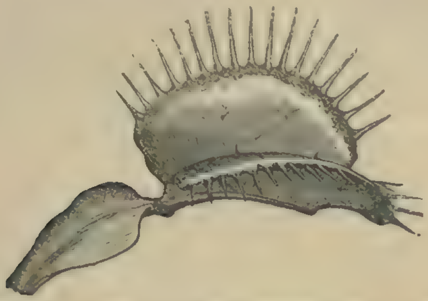

Fig. 5.—*Dionæa muscipula.* Leaf viewed laterally in its expanded state.

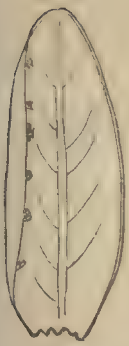

Fig. 6.

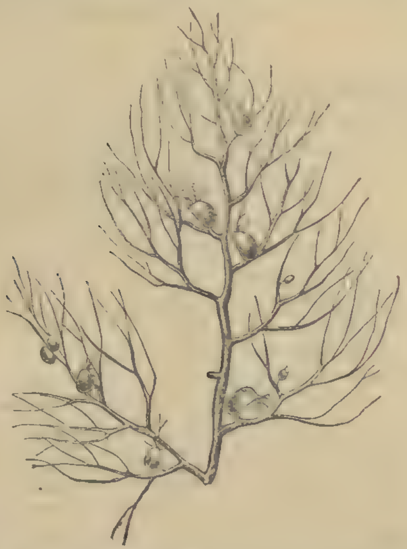

Fig. 7.

Fig. 6.—*Pinguicula vulgaris.* Outline of leaf with left margin inflected over a row of small flies.

Fig. 7.—*Utricularia neglecta.* Branch with the divided leaves bearing bladders; about twice enlarged.

Until the publication of the present volume, very little was known about the habits of the singular genus *Utricularia* or Bladderwort (Fig. 7), of which several species are natives of ditches, especially of very foul water, in this country. The very finely divided leaves bear a number of minute bladders about one-tenth of an inch in length, the form of which, as Mr. Darwin points out, bears a very singular resemblance to that of a minute Entomostracan Crustacean. Each bladder is furnished near its mouth with two long prolongations, which Mr. Darwin calls "antennæ," branching into a number of pointed bristles. On each side of the entrance to the bladder are also a number of bristles; and the entrance is itself almost entirely closed by a movable valve (Fig. 8), which rests on a rim or collar (the "peristome" of Cohn), dipping deeply into the bladder, and can only open inwards. The surface of the valve is furnished with a number of glands endowed with the power of absorption, but apparently not of secretion. The whole internal surface of the bladder, with the exception of the valve, is covered with a number of minute bodies—the "quadrifid processes" (Fig. 9)—consisting of four divergent arms of unequal length and grea

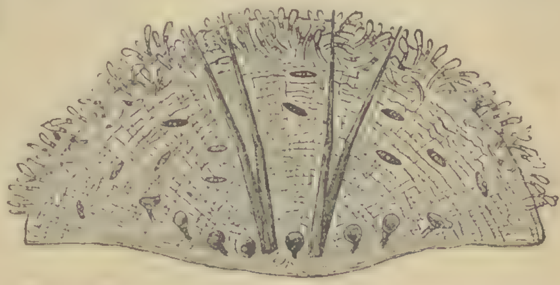

Fig. 8.—*Utricularia neglecta.* Valve of bladder; greatly enlarged.

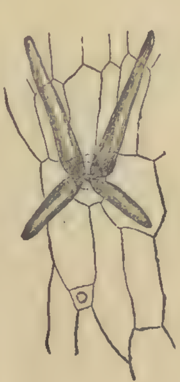

Fig. 9.

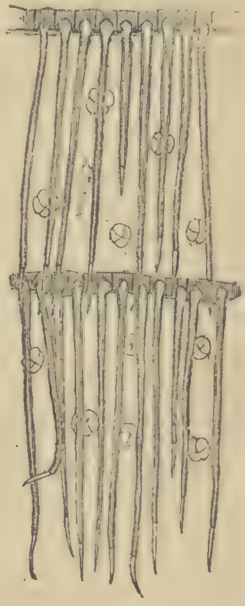

Fig. 10.

Fig. 9—*Utricularia neglecta.* One of the quadrifid processes greatly enlarged.

Fig. 10.—*Genlisea ornata.* Portion of inside of neck leading into the utricle, greatly enlarged, showing the downward pointed bristles, and small quadrifid cells or processes.

flexibility; the collar itself being furnished with similar but two-armed bodies.

The use of these bladders is not merely, like the air-bladders of *Fucus*, to support the plant in the water; they are employed to capture small aquatic insects and other animals, which they do on a large scale. What it is that attracts the animals to enter the bladders is at present unknown; but, having once entered by pressing down the valve, escape is almost impossible; they sometimes get closely wedged between the valve and the collar, and thus miserably perish. But the most mysterious part of the structure of *Utricularia* is that this beautiful and complicated arrangement for capturing prey is not accompanied by any correspondingly perfect arrangement for its digestion. No secretion whatever has been observed to exude from either the glands or the quadrifid processes; pieces of meat and albumen inserted within the bladders remained absolutely unchanged for three days; and it is only when the bodies of the captured animals begin to decay that the products of decomposition are slowly absorbed by the quadrifid processes; and of even this fact the evidence can only be said to be indirect, depending on a change observed in the appearance of the protoplasmic contents of the cells of the quadrifids and of the glands on the valve and bifids on the collar, similar to that which takes place in the tentacles of *Drosera* during digestion.

The above description is taken from the rare *Utricularia neglecta*, the species first observed by Mr. Darwin; the phenomena are essentially the same in the other British forms. An epiphytic South American species, *U. montana*, bears bladders of a similar structure in all essential points, which capture a quantity of minute animals. This species is also furnished on its rhizomes with a number of small tubers, which appear to serve as reservoirs of water during the dry season. Several other species were examined, including the Brazilian *U. nelumbifolia*, found only in a very remarkable habitat, floating on the water which collects in the bottom of the leaves of a large *Tillandsia* that inhabits abundantly an arid rocky part of the Organ Mountains at an elevation of about 5,000 feet above the level of the sea. In addition to the ordinary propagation by seed, this plant is said to put out runners which are "always found directing themselves towards the nearest *Tillandsia*, when they insert their points into the water and give origin to a new plant, which in its turn sends out another shoot."

It is very curious and suggestive to compare and contrast the contrivances displayed in the two genera, *Pinguicula* and *Utricularia*, belonging to the same natural order. In the latter case we have a most elaborate and perfect contrivance for capturing insects, reminding one of what Mr. Darwin describes elsewhere as "transcending in an incomparable degree the contrivances and adaptations which the most fertile imagination of the most imaginative man could suggest;" but, when the insects are once captured, there is no contrivance for hastening the decay of their tissues, or anything comparable to animal digestion. In *Pinguicula*, on the other hand, the digestive apparatus is most complete; but there is no means whatever of capturing insects, except the very perfectness of the digestive substance itself, the extremely viscid nature of the secretion from the glands. What was the primitive form which has developed into such very diverse structures in these nearly-allied genera? Here we have a problem for the evolutionist to work out; and another for the natural selectionist—what benefit to the plant were these contrivances in their elementary rudimentary stage?—a consideration necessary to the hypothesis of their having been produced by the action of selection. There is a difficulty in conjecturing what use a digestive fluid can have been to the *Pinguicula* before it attained a degree of perfection sufficient to capture insects, or rudimentary bladders to the *Utricularia*, seeing they were not endowed with the power of digestion.

The last genus examined by Mr. Darwin belongs also to the Lentibulariaceæ, the Brazilian *Genlisea*. It is also utriculiferous; but the bladders are of a very different nature to those of *Utricularia*, being simply hollow cavities in the very long petiole or narrow part of the lamina of certain leaves specialised for this purpose. The bladders are not more than $\frac{1}{36}$th of an inch in diameter, and are surmounted by a long tube fifteen times as long and only $\frac{1}{100}$ inch in diameter, which branches at the extremity into two arms coiled in a spiral manner. Very little is known of the habits of the plant, of which only dried specimens have been examined in this country. It is probable that insects creep down the long tube into the bladders, where their remains have been found, and there perish; but whether there is any process of digestion is unknown. The escape of insects once captured is prevented, not by a valve, as in *Utricularia*, but by rows of long thin hairs pointing downwards and springing from ridges which project from the inside of the tube, as shown in fig. 10. The inside of the utricle and of the neck are furnished in addition with a number of quadrifid processes, also represented in the figure, to which the function of absorption is ascribed, and which are compared to the "quadrifids" of *Urticularia*. The drawing of these processes, more than the description, reminds us strongly of certain structures which occur in the leaves of *Drosera* and *Pinguicula*, and which we do not find referred to in the present volume; nor do we know of any description of them elsewhere. Imbedded in the tissue of the leaf of both genera—in the former case often beneath the tentacles—are a number of bodies consisting of four cells and filled with a brown matter; and we cannot but think that attention directed to these bodies may be rewarded by a further insight into the processes of digestion and absorption. They are quite distinct from the papillæ described by Mr. Darwin in the case of *Drosera*. We have seen also analogous structures represented in drawings by Dr. Hooker of either *Nepenthes* or *Sarracenia*; and similar bodies occur in the leaves of some water-plants, as *Callitriche*, to which we are not aware that any function has been assigned.

We have attempted in this notice to introduce our readers only to some of the salient points of Mr. Darwin's researches; and cannot hope to give any idea of the unwearying labour, the precision of the experiments, and the wealth of illustration, for which we must refer all interested in the subject to the volume itself. The novelty of the results arrived at does not lie in the fact of plants being found to feed on organic matter whether animal or vegetable; physiologists have long been familiar with this power in the case of parasites and saprophytes, the former deriving their nourishment entirely from living organic matter, in some cases animal, in others vegetable; the latter from organic matter in a state of decay; but neither having the power of "assimilating," or obtaining their food-materials direct from the atmosphere and the inorganic constituents of the soil. *Saprolegnia* and *Cordiceps* are as fully entitled to the designation of carnivorous or even insectivorous plants as *Dionæa* or *Drosera*. The difference lies chiefly in the localisation of the power of absorption, which we have not generally considered to reside in the foliar organs. By far the most interesting facts brought out in this volume—and we think they are amongst the most important published for many years—are the changes from neutral to acid in the nature of the secretion poured out by the glands of Drosera on their excitement by contact with soluble nitrogenous substances; and the alleged "reflex" excitement of the tentacles of *Drosera*. It is impossible to foretell to what these discoveries will lead. We cannot but think that this volume will serve, as the previous ones from the same hand have done, to act as finger-posts to direct future observers in those lines of research which are likely to be the most fruitful and profitable.

ALFRED W. BENNETT

OUR BOOK SHELF

Progress-Report upon Geographical and Geological Explorations and Surveys west of the 100*th Meridian in* 1872, *under the direction of Brigadier-General A. A. Humphreys, Chief of Engineers, U.S. Army.* By First Lieutenant G. M. Wheeler.—Also *Topographical Atlas to illustrate Geographical Explorations west of the* 100*th Meridian*. (Washington: Government Printing Office, 1874.)

OUR readers are no doubt aware that a large area of the Western States of America is overrun by a number of expeditions intended mainly for the topographical and geological survey of that immense region. Some idea of the number and constitution of these parties will be obtained from two articles in NATURE, vol. viii. pp. 331 and 385. The "Progress-Report" for 1872 of that under charge of Lieut. G. M. Wheeler contains only brief notes of the work done by the various parties; detailed reports will, no doubt, be published eventually, and will occupy several volumes, besides atlases. The present brief report comprises notes of work done, not only in geology and topography, but also in astronomy, meteorology, natural history, ethnology, and photography. Some idea of the amount of work done may be obtained from the fact that the areas covered topographically during the summer months of 1872 exceeded 50,000 square miles lying in Utah, Nevada, and Arizona. The length of lines in the vicinity of which surveys were made is 6,127 miles, in addition to which other 2,067 miles had to be travelled for various purposes. A large portion of the present publication is occupied with reports on the numerous mining-stations which have been established in the district surveyed, as also on irrigation, agriculture, routes of communication, timber lands, and Indians; from the latter the expedition met with no interference, though of course it was accompanied by a military escort. One of the principal features of this report are the lithographic illustrations from camera-negatives of some of the magnificent cañons on the Colorado River; one of these illustrations gives a fine idea of a rain-sculptured rock at Salt-Creek Cañon, Utah.

The atlas which accompanies this Report is a magnificent work and reflects great credit on the U.S. Government and especially on the topographic section of Lieut. Wheeler's Expedition. Besides a general map, it consists of eight sectional maps in photo-lithography on the scale of one inch to eight miles, sufficiently large to give one an excellent idea of the nature of the country which has been surveyed. The maps are the results of the expeditions under Lieut. Wheeler in the years from 1869 to 1873, and embrace parts of California, Nevada, Utah, and Arizona. Every important feature is shown by characteristic and intelligible signs—mountain ranges, plateaux, cañons, bluffs, hills, craters, salt beds, sands, marshes, rivers, creeks, springs, &c., not to mention artificial features, as roads, trails, railroads, towns, &c. We understand that maps of the whole region west of the 100th meridian are to be published on this scale, and in some cases on a more extended one. It will be a magnificent work when complete, a work of which any country might be proud.

Nach den Victoriafällen des Zambesi. Von Edouard Mohr. 2 vols. (Leipzig: Hirt und Sohn, 1875.)

NOTWITHSTANDING that Herr Mohr went over ground that had been traversed previously, a considerable part of it being included in Livingstone's earlier travels, yet his book contains a great deal that is new and well worth publishing. From the time that he left Bremen in November 1868 till his departure from Africa in the beginning of 1871, the interest of his narrative never flags; the book contains frequent passages of genuine eloquence, quite free from bombast or affectation. During part of his journey, Mohr had as his companion the geologist Adolf Hübner, and their starting-point for the Victoria Falls was Durban. From this point they went almost directly to the falls, Hübner, however, leaving his companion before the Zambesi was reached, in order to visit the recently discovered South African diamond fields. Mohr, as we have indicated, tells the story of his journey and its many interesting incidents, particularly well, although, as might be expected, there were none of the dangers to be encountered which face explorers in less frequented parts of Africa. The book is full of valuable information of all kinds concerning the places touched at or visited both on the voyage out and on the journey from Durban to the Zambesi. The book must be considered as a specially valuable contribution to our knowledge of the natural history and geology, as well as to the geography of the district passed through. To the geographer the narrative will be found of very great value, as it contains a record of the carefully ascertained latitude and longitude of the principal points at which halts were made. Appended is a valuable paper by Hübner on the South African Diamond Fields. The work is illustrated by many good woodcuts and a few brilliant chromo-lithographs. There is also a small but clear map of South Africa, showing not only Mohr's route, but the routes of the principal travellers from Livingstone (1841) downwards. Altogether, the work must be considered a really valuable contribution to our knowledge of the region traversed, and seems to us well worth translating into English.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Spectroscopic *prévision* of Rain with a High Barometer

THAT the spectroscope should play a part in the prediction of weather for the common purposes of life was an early thought with many; but I have not heard of its resources being very distinctly appealed to in the late series of most memorable *μετέωρα* of the atmosphere which have passed over this country, setting nearly at naught most other methods of prediction.

If the instrument has been so used please to correct me. Otherwise permit me to say for myself, that being in Paris on Wednesday July 7, when the great physical and astronomical mathematician of the age, M. Leverrier, stood up in his place in the Academy of Sciences to explain how it had come about that the official predicter of the weather in the *Observatoire* had announced a fine dry period just before the destructive inundations in the South of France with all their train of frightful national calamities began,—I paid attention to the conclusion of his speech, which wound up with announcing "that all the bad symptoms had now (July 7) passed away, that the barometer was high in England, and that all the probabilities united pointed to a fine time coming."

Every day after that for a week the weather only became worse and worse, darker and wetter, in the usually gay city of Paris; and then I transferred myself to London, and was there on the 14th, 15th, and part of the 16th of July, a witness to, if possible, still worse weather, growing darker and wetter all the time. So much, then, for the failure of the ordinary methods of prediction, even in able hands; and let us be lenient to them, for who would or could have expected such deluges of rain with a high barometer, and in the month of July?

Now, however, comes an indication of where the spectroscope seems capable of saying something meteorologically useful: for in all that dark and wet weather in London a pocket spectroscope showed me from every part of the sky a broad dark band on the less refrangible side of D, and partly in the place of it. This band was so intense as to be the chief feature of the whole spectrum; and though no doubt "telluric" in its origin, was very different from the standard telluric effects seen at sunset in ordinary weather.

I feared at the time that this grandly dark spectral band might be of base artificial origin, such as an absorption effect by London smoke; and when journeying northward by rail on July 16, it was certainly charming to find that in proportion as we left London the rain ceased, the dark spectral band decreased, the clouds (amongst which, by the way, there were some remarkable counter-motions chiefly from north to south) diminished, and by the time we reached York fine weather prevailed. The ground there was dry, the rivers low, and the sky spectrum not only presented no dull bands, but the true D line was seen exquisitely fine and neat, as the thinnest imaginable spider-line in a telescope's illuminated field: so thin, fine, and clear indeed, as to offer a delight to the eye, such as none but an earnest spectroscopist can have any idea of.

Thus far, it is true, we have only had dark nebulous bands in place of fine sharp lines as *accompaniments* of rain, London rain too, with a high and steady barometer in the pleasant month of July. But mark, if you please, what follows.

The morning of the 17th of July, in Edinburgh, was glorious with pure blue sky, transparent atmosphere, delicious temperature, and light N.E. Wind. So, too, it continued all the day through, to the delight of thousands upon thousands in the streets. No smoke either was issuing from any of the factory chimneys, for there was a half-holiday or something more, and the usually working population was enjoying itself in the open air. The only clouds were a few brilliant and picturesque currents along the northern horizon, giving something like Alpine mountain snowy tops to the lovely undulations of the Scottish hills.

Simply beautiful were those bright cloud forms as an artistic feature in the general landscape; but in the spectroscope—why, good gracious! I could only say, what is the meaning of this? It was only a little pocket spectroscope, remember, without scale, and with small dispersion; but there was the D line appearing in seven times its usual strength, and with the London smoky band, too, beginning on its less refrangible side. Of the utterly abnormal intensification of D (or rather of some peculiar telluric lines so very near D as not to be separable from it in so small a spectroscope) in the light reflected from those clouds, there could not be the slightest doubt; for whenever the spectroscope was applied to a higher altitude than these clouds, there was little or nothing of the kind; only the usual Fraunhofer lines, fine and clean as generally seen in fine weather. The effect, too, was very different, both in spectrum place and distribution, from what is characteristic of a low sun; while the sun was at the time not low, no sunset colours had visibly begun, the clouds which gave the black intensification of the D line were almost absolutely white, and it was as yet only two o'clock on a fine bright July afternoon.

So I merely made comparative drawings of the spectrum given by these low white clouds, and that afforded by the general sky above them in the Polar neighbourhood, inked them in, and then waited to see what would follow.

And it was this. At 10 P.M. of that very fine day, and without any sensible falling of the high barometer, the sky clouded over completely. At 11 P.M. settled rain began. At 1.30 A.M. it was still raining, and I have reason to believe that it continued all night. It was certainly still raining in the morning of the next day, Sunday, and continued more or less all that day and all that night; while this morning, Monday, July 19, after a heavy thunderstorm, fog and heavier rain began and have proved the order of the day. All this with a barometer still nearly uninfluenced in its serene height and steadiness,* but not so the spectroscope, for, excepting the E line, all the other lines have disappeared in dull bands which occupy their places very nearly, and the London band on the less refrangible side of, and over D, is the main characteristic of all the visible spectral range.

15 Royal Terrace, Edinburgh, PIAZZI SMYTH
July 19 Astronomer Royal for Scotland

OUR ASTRONOMICAL COLUMN

THE TRIPLE-STAR, SOUTH 503.—In *Astron. Nachr.*, No. 2,045, Baron Dembowski has published measures of this star made in 1873-75, which exhibit large changes in the relative situation of the components, as compared with the measures of Sir James South early in the year 1825. Thus we have for A and B:—

South.........	1825·1	Position	134°·1	Distance	39″·94
Dembowski.	1873·80	,,	120 ·3	,,	8 ·24
,,	1875·21	,,	118 ·8	,,	7 ·07

And for A and C:—

South.........	1825·1	Position	337°·3	Distance	201″·76
Dembowski.	1875·21	,,	335 ·4	,,	232 ·04

Lalande observed A and C on Jan. 23, 1798; Bessel observed all three components on March 6, 1823; and Argelander has an observation of B on Feb. 16, 1856.

On inspecting the above measures there will arise at first sight a suspicion that the change of distance between A and C and in both elements between A and B may be caused by proper motion of A nearly in the line joining A and C. To put this to the test we may take a mean between South's measures of 1825 and the angle and distance of A and C deduced from Bessel's meridian observations in 1823, and compare it with the mean of Dembowski's measures of A and C in 1875. Assuming the differences to be due to proper motion of A, we find for the annual values:—

P.M. in R.A.	+ 0″·389
P.M. in Decl.	− 0 ·461

And, if with this proper motion we reduce Dembowski's mean of measures of A and B in 1875 to the epoch of South's observations there results:—

For 1825·1 ... ... Position 136°·5 Distance 36″·5

Considering that the P.M. adopted is only an approximation, there appears to be little doubt that the changes to which the Baron Dembowski has drawn attention in his

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* *Meteorological Journal at Royal Observatory, Edinburgh, for* 1 P.M. *each day.*

1875.	Barometer reduced to sea-level.	Attached Thermometer.	Exterior Thermometer.	Direction of wind.
July 14	29·961	56°·2	58°·4	N.E.
,, 15	30·060	56·3	55·4	E.N.E.
,, 16	30·098	57·1	58·1	N.E.
,, 17	30·043	59·0	59·6	N.E.
,, 18	—	—	—	—
,, 19	29·995	58·3	57·0	N.E.

interesting note are really due to the proper motion of the principal component of this triple star.

LALANDE 23726 (CORVUS).—With reference to the query as to actual brightness of this star, which has been noted as high as a fifth magnitude by Heis (NATURE, vol. xii. p. 27), Mr. J. E. Gore writes from Umballa, under date June 8:—"I last night examined its place and found the star in question to be barely visible in an opera glass or about mag. 8." It is evidently variable to a considerable extent, and should be closely watched. Mr. Gore adds that "L. 23675-76 rated 7, 7½ by Lalande, is now about 6m., and brighter than the stars L. 23463 (6m.) and 23446 (6m.), a little to the west;" the observations in the *Histoire Céleste*, however, do not belong to the same object, but to the two components of a double-star, which is Σ 1669, and in the Dorpat scale were both estimated 6·5 in *Mensuræ Micr.*, and 6·0 in *Positiones Mediæ*; their distance about 5½″. Bessel also observed both components, judging them of equal brightness and of the seventh magnitude in his scale. The appearance of the object to the naked eye as a bright sixth, remarked by Mr. Gore, is thus accounted for.

HORIZONTAL REFRACTION ON VENUS.—In May 1849 near the inferior conjunction of Venus with the sun, Clausen having remarked that the crescent extended beyond a semicircle, Mädler observed it with the Dorpat telescope, with the view of approximating to the amount of horizontal refraction in the planet's atmosphere. Measures, properly so called, he found were hardly feasible, owing to the extreme faintness of the cusps and proximity of the planet to the sun, but estimations with a position-wire in the field of view were made on six days at distances varying from 3° 26′ to 7° 37′; the mean gave for the horizontal refraction, 43′·7. In 1866 Prof. C. S. Lyman, by similar observations, obtained 45′·3; he remarked: "The planet was then (for the first time, as it appears) seen as a very delicate luminous ring. The cusps of the crescent, as the planet approached the sun, had extended beyond a semicircle, until they at length coalesced and formed a perfect ring of light." Last December Prof. Lyman repeated these observations, making use of a five-feet Clarke telescope of 4⅜ inches aperture, and by measures of the extent of the crescent on four days, deduces for the horizontal refraction of the atmosphere of Venus, 44′·5, a value which is also the mean of the three sets of observations. (*American Journal of Science and Arts*, January 1875). At the next inferior conjunction of Venus, she will have the following angular distances from the sun's centre, at Greenwich noon:—

1876, July 11 ...	6° 28′	July 14	5° 8′
,, 12 ...	5 35	,, 15	5 33
,, 13 ...	5 5	,, 16	6 23

The formula used for finding the horizontal refraction may be thus written, putting C for the observed extent of the crescent, *d* for the angular distance of Venus from the sun at the time of observation, *s* for the sun's semi-diameter, which we may express in minutes of arc, and *r* for the planet's radius-vector:—

$$\text{Hor. Refr.} = \frac{1}{2}\left\{\text{Arc}\sin d \sin \tfrac{1}{2}\,(\text{C}-180^\circ) - \frac{s}{r}\right\}$$

THE SUN'S PARALLAX.—We have received Prof. Galle's *Bestimmung der Sonnen-Parallaxe aus correspondirenden Beobachtungen des Planeten Flora* (Breslau, 1875), which contains the full details of his reduction of the observations taken in both hemispheres near the opposition of the planet in 1873, when it approached the earth within about 0.87 of our mean distance from the sun. The final result for the parallax 8″.873, as already stated in this column, corresponds to 23,247 equatorial semi-diameters of the earth, or, according to Galle, 19,979,000 geographical miles of 15 to the degree of the equator.

SCIENCE IN SIAM.

WHEN the invitation of the King of Siam to observe the late total eclipse of the sun reached the Royal Society, it was hailed with delight by those who took an interest in the expedition. A few Europeans professing to know something about the country wrote letters to newspapers discouraging astronomers from accepting the invitation. Happily no notice was taken of these anonymous letters, and the result was that the members of the expedition were surprised, not only by the good reception they met with everywhere in Siam, but also by the great interest the Siamese themselves took in the eclipse and in science generally. The late king was well known for his love of astronomy, but many might suppose that this was a solitary case, and that with the death of the king science would be left unprotected in the country. A short account of our experience will show that the interest the Siamese take in science is rather on the increase than on the decrease.

On our way to the observatory, which was erected at Bangtelue, near Chulie Point, we had to stop twenty-four hours in Bangkok until the steamer which was to take us was ready. It happened that the evening of that day the "Young Siamese Society" met in the house we were staying at, and I was asked by the members to give a lecture on spectrum analysis and its application during solar eclipses. Mr. Alabaster, aided by the King's private secretary and Prince Dewan, acted as interpreter. The Siamese listened with the greatest interest, and by the questions they asked after the lecture was over showed that they fairly understood the subject. There exists a Siamese translation of a book on chemistry, and they had read up the subject in that book. H.R.H. Chowfa Maha Mala, uncle of the King, is the chief astronomer of the Siamese at the present time. He showed me the way in which he had determined the time and duration of the eclipse at Bangkok. Taking the sun and moon's apparent diameter from the *Nautical Almanac*, he determined by means of the projection of their paths and their apparent velocity the time of the different contacts. The drawing was neatly executed and, I am told, the time thus determined came very near the truth.

On the day of the eclipse several telescopes, one of which had been lent to the King by Dr. Janssen, were set up on the lawn in the front of the palace. The local time was determined by Mr. Alabaster and Capt. Bush, in order to find the exact time of the different contacts. As totality approached, the King made a speech to the members of the Royal Family, who were all assembled, telling them why solar eclipses were observed, and why large sums of money were spent for that purpose. During totality, his Majesty observed the corona and the protuberances through a telescope, carefully noting down what he saw and making a sketch of the protuberances. He had ordered one of the princes to take photographs of the corona. Two photographs were thus secured, which by no means are inferior to those taken at the Observatory of Bangtelue. The original negatives of these photographs have been sent to England as a present from the King to the Royal Society.

At our camp the Siamese also showed a great interest in the eclipse. The eagerness with which the ex-Regent looked through his telescope contrasted in a characteristic way with the quiet indifference with which his European secretary went to sleep during totality.

The King of Siam informed us that he did not profess to be an astronomer, and I was therefore rather surprised to hear afterwards that on his journey to Calcutta he had taken regular sights with the sextant, and calculated himself the position of the steamer.

But the taste of the Siamese for science is not merely confined to astronomy. Wangna, the second king, is a mineralogist. The country in which he lives gives him ample opportunity to work at his favourite subject. He has a large mineralogical collection and a nice chemical laboratory, in which he makes his analyses.

Let us now turn from what the Siamese have done for science to what they are going to do.

The King has instructed Dr. Gowan to erect an observatory in which regular barometric and thermometric measurements are to be made. The rainfall and the tides will also form a subject of measurements. Other instruments will be added in time. As the Siamese have a great fancy for photography, we shall perhaps soon see regular photographs of the sun taken in Bangkok. Various spectroscopes and telescopes are at the present moment on their way out from England. It is also intended to build a chemical laboratory in the palace. The King's bodyguard are being instructed by Mr. Alabaster in taking surveys. At the moment I write this, they are out on a surveying expedition.

All this shows that the inhabitants of Siam have a great fancy for science, if it does not show more. Strong liking for a subject is generally accompanied with, if not caused by, the ability to deal with it and to overcome its difficulties. Let us hope that some of the Siamese will take up their favourite subject, not as amateurs merely, but with all the seriousness of a profession. Many of them visit Europe for several years. If some of these were to go through a course of science, the knowledge thus gained, added to their natural intelligence and love of science, would soon make them good observers and able experimenters.

In the meantime it will be interesting to watch the growth and development of a country in which science is the recognised and favourite study. English men of science cannot refuse their sympathy to a king who, under great difficulties, does his best to improve his country, and who readily accords to science the position which they are striving to obtain for it in their own land.

ARTHUR SCHUSTER

THE RESTING-SPORES OF THE POTATO FUNGUS

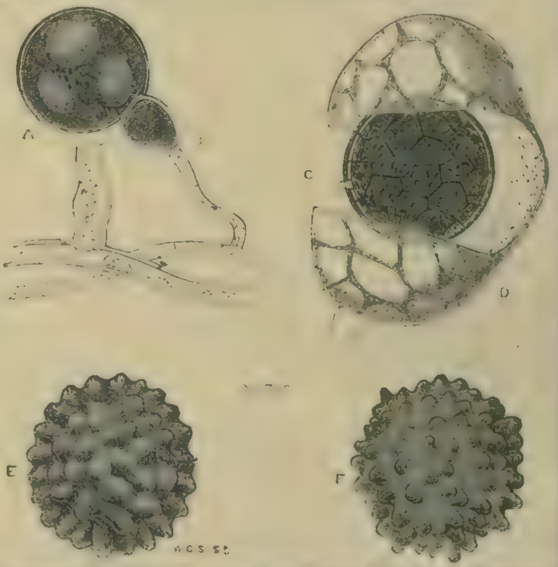
FOR some reason unknown to me (but probably owing to meteorological conditions pertaining to this season or the last) the potato fungus began its ravages this summer a month or six weeks earlier than usual. It not only appeared out of season, but it came in a different form from anything within the memory of the younger botanists of the present generation. It is considered probable that the present condition of the disease is similar with that long ago known as "the curl," a pest known a considerable time before *Peronospora infestans*, Mont., was described as European.

At the beginning of June I had potato-leaves sent to me for examination from the office of the *Journal of Horticulture*; these leaves were badly diseased, spotted and fœtid, and from certain of the stomata a few threads of the *Peronospora* were emerging; this fact, from the unusually early appearance of the fungus, I made a special note of.

On June 16 Mr. Berkeley brought leaves sent to him for examination by Mr. Andrew Murray, (which were spotted in an exactly similar manner with mine), to the meeting of the Royal Horticultural Society. At the same time Mr. Berkeley exhibited a sketch of two rather large nodulose (or reticulated) bodies found by him within these leaves, as a possible species of *Protomyces*, but since then known to be the resting-spores of *Peronospora infestans*, Mont., here illustrated.

The presence of these warted bodies in the leaves, as seen by Mr. Berkeley, led me to make a searching examination of the Chiswick plants then greatly suffering from the pest, and I at once found similar bodies very sparingly diffused amongst the tissues of the leaves, with a few branches of *Peronospora* and threads of mycelium, and two semi-transparent bodies of different sizes which were new to me. On attempting to disengage these presumed specimens of *Protomyces* from the black, hard, and corroded spots on the leaves by maceration in water, I found the continued moisture greatly excited the growth of the mycelium. After the lapse of a week the threads bore (amongst the intercellular spaces of the leaves) the semi-transparent bodies of two sizes which I had before seen and measured, and which I now refer without doubt to the oogonium and antheridium of the potato fungus. It is very uncommon to find a fungus bearing sexual and asexual fruit at the same period of growth, and in this instance the old asexual fruit was very sparingly produced. I, however, afterwards found the fungus with both forms of fruit and with ripe free resting-spores, inside the cavities of the putrid stems, and I found the ripe resting-spores and the sexual organs sometimes in conjugation within the tissues of the potato tubers when the substance was reduced by decomposition to the softness and semi-transparency of butter.

By keeping the potato-plants closely under observation from that time to this, a period of from six to seven weeks, I have seen and figured these bodies in every stage of growth, and have been able to preserve some of the best material for future careful mounting. Those who may care to know in detail how, from the slightest clue at first, the subject was worked out to its present aspect may refer to the *Gardener's Chronicle* for July 10, 17, and 24 last, and to this week's *Journal of Horticulture.*



Oogonium antheridium and mature resting spore of *Peronospora infestans*, Mont.

The antheridia, oogonia, and oospores (or resting-spores) in *Peronospora infestans*, Mont. are very similar, with the same bodies in other species of *Peronospora*, in fact when they are drawn to scale and placed side by side there is very little difference to be detected. The accompanying illustration shows the oogonium (A) and antheridium (B) in contact as taken from the tissues of the leaf. At C is shown a semi-mature resting-spore with its fecundating tube attached and its coat of cellulose accidentally pushed aside by maceration in water, as taken from a putrid potato-stem. At E is illustrated the perfectly mature resting-spore, free from its coat of cellulose taken from a tuber in the last stage of decomposition. At F is shown the resting-spore of *Peronospora arenariæ*, Berk, drawn to exactly the same scale to show similarity in size and conformation. The figures in the cut are uniformly enlarged seven hundred diameters, and the mature oospore or resting-spore measures on the average ·00142 inch in in length, and ·00114 inch in breadth.

WORTHINGTON G. SMITH

ELECTRICAL RESISTANCE THERMOMETER AND PYROMETER[*]

THIS paper consists of three parts. The first treats of the experiments made by Dr. Siemens, with a view of determining the law of the variation of electrical resistance in metallic conductors, with variation of temperature, through a greater range than had been before attempted. The second describes certain instruments, by whose use this law is applied to the measurement of temperature. The third treats of a simple method of measuring electrical resistance by means of the differential voltameter.

Our author first refers to the previous experiments made by Arnsted, by his brother, Dr. Werner Siemens, and by Dr. Matthiessen, and to the law deduced by Clausius, "that the electrical resistances of metals are directly proportional to their absolute temperatures." The maximum range of these experiments was 100° C. Dr. Siemens's experiments were made upon copper, iron, steel, silver, aluminium, and platinum; the last of these has received the most attention at his hands, as, having the highest melting point, it is the most valuable from a practical point of view.

The method employed in one series of experiments was to wind metal wire upon pipe-clay cylinders, having helical grooves to prevent contact between the convolutions of the wire, and to place these, together with three delicate thermometers, in a copper vessel enclosed in a larger one containing linseed oil, and having hollow sides packed with sand to diminish sudden variation of temperature. The bath was gradually heated by means of Bunsen's burners to 340° C., or close to the boiling point of mercury, and the readings were made with a Wheatstone's bridge and delicate galvanometer. A second series of experiments was made in a heated air vessel having a metallic screen to prevent irregular losses of heat by radiation or by atmospheric currents, the other conditions being similar to those in the first series. The results obtained were found to accord generally with those of Matthiessen and the other observers within the limits of their experiments, but pointed to a different law of increase beyond those limits. The formula hitherto known as Matthiessen's is—

$$R_t = \frac{R_v}{1 - \cdot0037647\,t + \cdot00000834\,t^2}$$

and was the mean of the results obtained on various metals. This formula is shown to give discordant results at the higher temperatures, as the calculated resistance at 300° C. is 1·61 nearly of what it is at 0° C., whilst at 2000° C. it is ·0373, showing clearly that the formula is reliable only between very narrow limits.

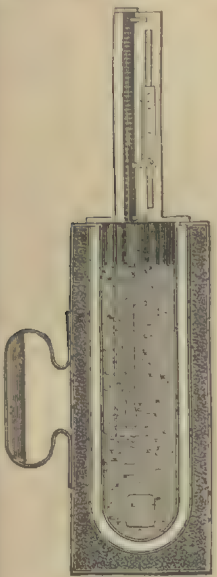


FIG. 1.

We quote the author as to the law of resistance which he proposes: "Now, if we apply the mechanical laws of work and velocity to the vibratory motions of a body which represent its free heat, we should define this heat as directly proportional to the square of the velocity with which the atoms, or may be the molecules, vibrate.

"We may further assume that the resistance which a metallic body offers to the passage of an electrical impulse from atom to atom, or from molecule to molecule, is directly proportional to the velocity of the vibrations which represent its heat. In combining these two assumptions, it follows that the resistance of a metallic body increases in the direct ratio of the square root of the free heat communicated to it. Algebraically, if r represent the resistance of a metallic conductor at the temperature T, reckoning from the absolute zero, and α, an experimental coefficient of increase peculiar to the particular metal under consideration, we should have the expression—

$$r = \alpha\,\mathrm{T}^{\frac{1}{2}}.$$

This purely parabolic expression would make no allowance for the probable increase of resistance, due to the increasing distance between adjoining particles with increase of heat, which would depend upon the coefficient of expansion, and may be expressed by $\beta\,\mathrm{T}$, which would have to be added to the former expression. To these factors a third would have to be added expressing an ultimate constant resistance of the material itself at the absolute zero, and which I call γ. The total resistance of a conductor at any temperature, T, would, therefore, be expressed by the formula—

$$r = \alpha\,\mathrm{T}^{\frac{1}{2}} + \beta\,\mathrm{T} + \gamma.$$

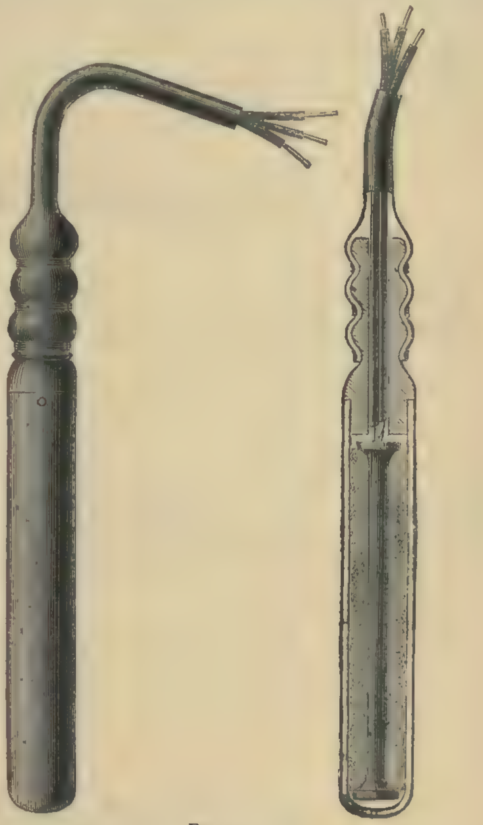


FIG. 2.

Diagrams are given in which this hypothetical law is graphically represented, and in which its results are compared with those obtained by the experiments already cited, and by this means the {following formulæ are arrived at for the different metals named :—

For platinum $r = \cdot0021448\,\mathrm{T}^{\frac{1}{2}} + \cdot0024187\,\mathrm{T} + \cdot30425$

$r = \cdot039369\,\mathrm{T}^{\frac{1}{2}} + \cdot00216407\,\mathrm{T} - \cdot24127$

$r = \cdot092183\,\mathrm{T}^{\frac{1}{2}} + \cdot00007781\,\mathrm{T} - \cdot50196$

For copper ... $r = \cdot026577\,\mathrm{T}^{\frac{1}{2}} + \cdot0031443\,\mathrm{T} - \cdot29751$

,, iron ... $r = \cdot072545\,\mathrm{T}^{\frac{1}{2}} + \cdot0038133\,\mathrm{T} - 1\cdot23971$

,, aluminium $r = \cdot05951436\,\mathrm{T}^{\frac{1}{2}} + \cdot00284603\,\mathrm{T} - \cdot76492$

,, silver ... $r = \cdot0060907\,\mathrm{T}^{\frac{1}{2}} + \cdot0035538\,\mathrm{T} - \cdot07456$

Dr. Siemens, however, has not been satisfied with limiting his experiments to temperatures within the boiling point of mercury, but compared the law he had deduced with experimental results at higher temperatures obtained by the use of the metal ball pyrometer shown in Fig 1. Its principal parts are a metal ball, whose heat capacity equals one-fiftieth of that of an imperial pint of water, a copper vessel containing a pint of water, and a thermometer having a fixed and sliding scale with divisions of equal size, but each division in the latter being equivalent to fifty in the former. The zero of the sliding scale is fixed to coincide with the position of the mercury level in the thermometer. The ball, having been heated, is dropped into the water, whose temperature is the sum of those indicated on the fixed and sliding scales. By the use of this instrument, whose readings were compared with those of the mercury thermometer up to the boiling-point of the latter metal, results at higher temperatures were obtained. The first part concludes with several pages of tabulated results of experiments, which results are laid down in a sheet of diagrams.

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[*] Abstract of a Paper read at the Society of Telegraph Engineers by C. William Siemens, D.C.L., F.R.S., &c.

In the second part, Dr. Siemens describes the instruments he has designed for the measurement of temperature by electrical resistance, having first referred to the coils of silk-covered copper wire, by which he was enabled to detect a dangerous rise of temperature in the Malta and Alexandria Telegraph cable, coiled in ship's hold, and saved that cable from being destroyed. The simplest of these arrangements is shown in Fig. 2, and is employed for the measurement of temperature not exceeding the boiling point of water. Insulated wire is wound round a cylindrical piece of wood and is enclosed in a metal casing: one end is joined to a thicker insulated wire, and the other to a similar one soldered to it; this is called the thermometric resistance coil or thermometer coil. The thermometrical comparison coil is formed of an exactly similar wire, and has an equal resistance with the other. The wire is wound upon a metal tube, and is enclosed in a protecting capsule of metal, in the open end of which is fitted a vulcanite stopper through which are passed the leading wires attached to the coil. This is placed in a movable tube having a flanged bottom and containing a mercury thermometer; the tube is immersed in a cylindrical vessel of water, wherein it is moved up and down, the flange agitating and thus equalising the temperature of the water. The thermometer coil, which may be at a distance from the place of observation, is connected with the comparison coil through a pair of equal resistances and a galvanometer. When electrical equilibrium is obtained, by adding hot or cold water to the vessel containing the comparison coil until the galvanometer needle is at the zero of its scale, it is evident that $\frac{A}{B} = \frac{T + l}{T' + l'}$, A and B representing the equal resistances, l and l' the equal resistances of the leading wires, and T T′ those of the thermometer and resistance coils, or T = T′, and the temperature of the water in which the comparison coil is placed will be that of the distant station.

In measuring deep-sea temperatures the coil must be so protected as to be perfectly insulated at the greatest depths, and the wire so coiled as to be effected by slight variations of temperature in its vicinity. The necessary instrument is shown in the sketch Fig. 3, which represents an insulated wire coiled on a metal tube; one end of the wire is soldered to the tube, the other to a copper wire insulated with gutta percha, and carried through a hole to the interior: over each end of the tube is drawn a piece of vulcanised india-rubber pipe, and over the whole a larger piece of india-rubber tubing, which, after being padded outside with hemp yarn, is lashed tightly with a stout binding wire. The gutta-percha covered wire is placed between the india-rubber pipes *b* and *c*, its end being soldered to one of the leading wires, the other leading wire being soldered to the brass tube. The whole is carried at the end of the sounding line, which contains the leading wires. These coils are tested under hydrostatic pressure, and accurate readings are obtained to a tenth of a degree Fahrenheit.

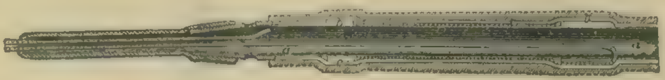

FIG. 3.

The only difficulty that has hitherto arisen in the employment of this instrument has been the obtaining of skilled observers to note with accuracy the indications of the galvanoscope on board ship.

The next instrument described is the electrical pyrometer, the coil of which is made of platinum wire, wound on a hard baked pipe-clay cylinder in which a doubled threaded helical groove is formed, and which is shown in Fig. 4.

At each end of the spiral portion B B, it is provided with a ring-formed projecting rim *c* and *c′*, the purpose of which is to keep the cylinder in place when it is inserted in the outer metal case, and to prevent the possibility of contact between the case and the platinum wire. Through the lower ring *c′* are the small holes *b b′*, and through the upper portion two others, *a a*. The use of the upper holes *a a′* is for passing the ends of the platinum wires through, before connecting them with the leading wires. From these two holes downwards platinum wires are coiled in parallel convolutions round the cylinder to the bottom, where they are passed separately through the holes *b b′*. Here they are twisted, and by preference fused together by means of an oxyhydrogen blow-pipe. At this end also the effective length and resistance of the platinum wire can be adjusted, which is accomplished by forming a return loop of the wire, and providing a connecting screw-link of platinum, L, by which any portion of the loop can be cut off from the electrical circuit.

The pipe-clay cylinder is inserted in the lower portion of the protecting case seen in Fig. 6. This part of the case is made of iron or platinum, and is fitted into the long tube, which is of wrought iron, and serves as a handle. When the lower end of the casing is of iron, there is a platinum shield to protect the coil on the pipe-clay cylinder. The purpose of the platinum casing is to shield the resistance wire against hot gases, and against accident. At the points A A, Fig. 4, the thick platinum wires are joined to copper connections, over which pieces of ordinary clay tobacco-pipe are drawn, and which terminate in binding screws fitted to a block of pipe-clay, closing the end of the tube. A third binding screw is provided, which is likewise connected with one of the two copper connecting wires, and which serves to eliminate disturbing resistances in the leading wires. The pipe-clay cylinder is, when cold, highly insulating; its conducting power increases with heat, but not to an extent to produce error, as the variation is inappreciable until a white heat is reached, but in measuring temperatures above a white heat, the indications of the instrument are slightly below the true value. In measuring temperatures with this instrument the differential voltameter is employed, a wide range of resistances being obtained; this instrument forms the subject of the third part o this paper, to which we now refer. The theory of differential measurement and the instrument employed are thus described by Dr. Siemens:—

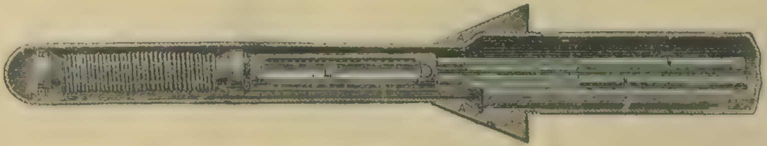

FIG. 4.

Faraday established the law that the decomposition of water in a voltameter in an unit of time is a measure of the intensity of the current employed; or, that

$$I = \frac{V}{t};$$

—I being the intensity, V the volume, and t the time.

According to Ohm's general law, the intensity, I, is directly governed by the electro-motive force, E, and, inversely, by the resistance, R, of the electric circuit, or, it is

$$I = \frac{E}{R}.$$

Combining the two laws we have

$$V = \frac{E}{R} t,$$

which formula would enable us to determine any unknown resistance, R, by the amount of decomposition effected in a voltameter in a given time, and by means of a battery of known electromotive force.

Practically, however, such a result would be of no value, because the electromotive force of the battery is counteracted by the polarisation, or electrical tension, set up between the electrodes of the voltameter, which depends upon the temperature and concentration of the acid employed, and upon the condition of the platinum surfaces composing the electrodes. The resistance to be measured would, moreover, comprise that of the voltameter, which would have to be frequently ascertained by other methods, and the notation of time would involve considerable inconvenience and error. For these reasons the voltameter has been hitherto discarded as a measuring instrument, but the disturbing causes just enumerated may be eliminated by combining two similar voltameters in one instrument, which I propose calling a "differential voltameter," and which is represented in the accompanying drawing.

It consists of two similar narrow glass tubes, A and B, of about 2·5 millimetres in diameter, fixed vertically to a wooden frame, F, with a scale behind them divided into millimetres or other divisions. The lower ends of these tubes are enlarged to about 6 millimetres in diameter, and each of them is fitted with a wooden stopper saturated with paraffin and pierced by two platinum wires, the tapered ends of which reach about 25 millimetres above the level of the stopper. These form voltametric electrodes.

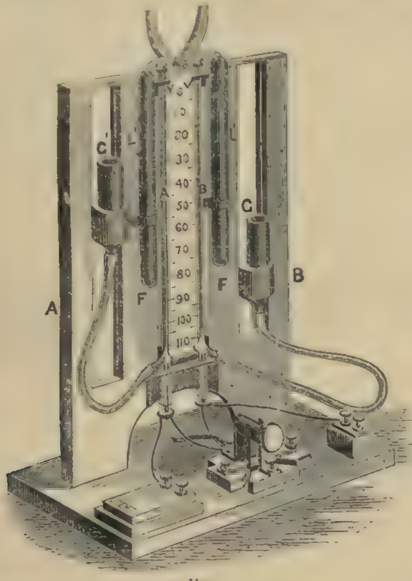

FIG. 5.

From the enlarged portion of each of the two voltameter tubes a branch tube emanates, connected, by means of an india-rubber tube, the one to the moveable glass reservoir G, and the other to G', Fig. 5. These reservoirs are supported in sliding frames by means of friction springs, and may be raised and lowered at pleasure. The upper extremities of the voltameter tubes are cut smooth and left open, but weighted levers, L and L', are provided, with india-rubber pads, which usually press down upon the open ends, closing them, but admitting of their being raised, with a view of allowing the interior of the tubes to be in open communication with the atmosphere. Having filled the adjustible reservoirs with dilute sulphuric acid on opening the ends of the voltameter tubes, the liquid in each tube will rise to a level with that of its respective reservoir, and the latter is moved to its highest position before allowing the ends of the tubes to be closed by the weighted and padded levers.

The ends of the platinum wire forming the electrodes may be platinised with advantage, in order to increase the active surface for the generation of the gases.

Fig. 6 represents the connections of the voltameter with the pyrometer. One electrode of each voltameter is connected with a common binding-screw, which latter may be united, at will, to either pole of the battery, whilst the remaining two electrodes are, at the same moment, connected with the other pole of the same battery; the one through the constant resistance-coil, X, and the other through the unknown resistance, X'. This unknown resistance, X', is represented to be a pyrometer-coil.

By turning the commutator seen at Fig. 5 either in a right or left-hand direction from its central or neutral position (in which position the contact-springs on either side rest on ebonite), the current from the battery flows through the two circuits, causing decomposition in the voltameters; and the gases generated upon the electrodes accumulate in the upper portions of the graduated tubes. By turning the commutator half round every few seconds, the current from the battery is reversed, which prevents polarisation of the electrodes, as already stated.

The relative volumes, v and v', of the gases accumulated in an arbitrary space of time within each tube must be inversely proportional to the resistances, R and R', of the branch circuits, because—

$$v : v' = \frac{E}{R}t : \frac{E}{R'}t,$$

and, therefore,

$$v : v' = R' : R.$$

The resistances R and R' are composed, the one of the resistance

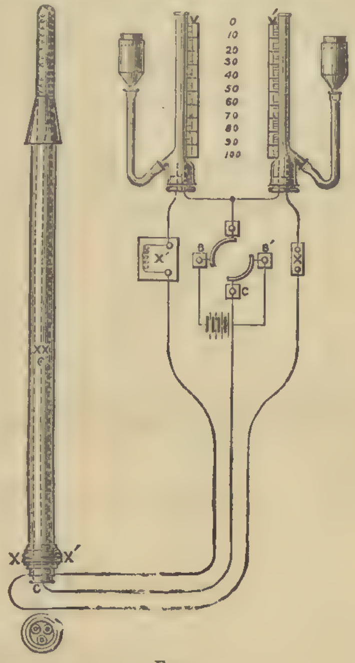

FIG.

C, plus the resistance of the voltameter A, and the other of the unknown resistance X, plus the resistance of the voltameter B. But the instrument has been so adjusted that the resistances of the two voltameters are alike, being made as small as possible, or equal to about 1 mercury unit, to which has to be added the resistances of the leading wires, which are also made equal to each other, and to about half a unit; these resistances may therefore both of them be expressed by γ.

We have, then—

$$v' : v = C + \gamma : X + \gamma,$$

or—

$$X = \frac{v}{v'}(C + \gamma) - \gamma \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which is a convenient formula for calculating the unknown resistance from the known quantities C and γ, and the observed proportion of v and v'.

The constant of the instrument (~) is easily determined, from time to time, by substituting a known resistance for X, and observing the volumes, v and v', after the current has been acting during an arbitrary space of time, when in the above formula, γ, has to be separated as the unknown quantity, giving it the form—

$$\gamma = \pm \frac{v' X - v C}{v - v'} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The condition of equality between the internal resistances of both voltameters is ascertained by inserting equal known resistances in both branch circuits, when

$$v = v'$$

should be the result. Failing this, the balance is generally re-established by reversing the poles of the battery, the reason being that hydrogen electrodes are liable to accumulate metallic or other deposit upon their surfaces, which is effectually removed by oxygen.

When the instrument is to be worked between wide ranges of temperature, it is requisite that C should be variable, and nearly equal to X, and that γ should be very small compared with X.

By equating the values of the equations

$$X = \frac{v}{v'}(C+\gamma) - \gamma = r = \cdot 039369\, t^{\frac{1}{2}} + \cdot 00216407\, t - \cdot 24127,$$

C and γ in the instruments constructed being equal to 17 and 2 units, we arrive at

$$t^{\circ}\text{Cent.} = \left\{ \left(877\cdot 975 \times \frac{v}{v'} + 101\cdot 80877\right)^{\frac{1}{2}} - 9\cdot 0960553 \right\}^{2} - 274^{\circ},$$

from which a table has been prepared to be used with the pyrometer.

The precautions which have to be taken to insure reliable results in using the Differential Voltameter are:—

1st. The dilute acid employed in both tubes should be of equal strength.

2nd. After disuse, the equality of the resistances of the voltametres and connection should be verified by passing the current through them with equal resistances in each branch.

3rd. The battery power should be proportional to the resistances to be measured, whilst owing to the voltameter exercising an opposing electro-motive force by polarisation, less than five Daniell's elements should not be employed.

4th. The india-rubber pads should be smeared from time to time with a waxy substance such as resin cerate.

With these precautions the measurements of the instrument have been compared with a very perfect Wheatstone bridge arrangement, and tables of results are given showing that it can be relied upon to within one-half per cent. of error of observation. Its principal advantages are stated to be: that the resistance is measured in work done, and does not therefore depend upon a momentary observation, that it is not influenced by motion on board ship or by magnetic disturbances, and that its construction is so simple that each part can be easily examined and verified.

It is regarded, however, only as a useful adjunct to the more important subject of thermometry, which forms the principal object of this paper.

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*THE GIGANTIC LAND TORTOISES OF THE MASCARENE AND GALAPAGOS ISLANDS**

EVER since the foundation of Natural History Collections in Europe, naturalists had their curiosity excited by shells of Tortoises of enormous size that were brought home in vessels coming from India. From the accounts of travellers as well as from the great convexity of their shell, these tortoises were known to be terrestrial in their life, and totally distinct from the other giants of the Chelonian order, the marine Turtles. Various localities having been given as their habitat, such as the Cape of Good Hope, the Coast of Coromandel, Malacca, China, &c., the impression prevailed that they were found in many parts of India, and consequently nothing could have been more appropriate than the name given to them, *Testudo indica*.

It is not the object of the present article to treat in detail of the divergent views held subsequently by zoologists, some distinguishing several species from the difference of the form of the shell alone, others maintaining that there was one very variable species only which had been carried by ships from its native place into various parts of the globe where it became acclimatised, until Dr. Gray, the principal advocate of the latter opinion, himself was compelled to admit that there must be at least two kinds, one with a convex and the other with a flat skull. The scientific study of these tortoises may be said to have commenced with this distinction, but it commenced at a time when the work of disturbance and extermination by man had already reduced the amount of evidence so far as to well nigh bring the subject into the domain of palæontological research.

From the accounts of voyagers of the sixteenth and seventeenth centuries we learn that these tortoises were found at two most distant stations, one being the Galapagos group in the Pacific, the other comprising some of the islands of the Indian Ocean; Mauritius, Rodriguez, Aldabra, and probably Réunion. Widely different as these stations are in their physical characteristics, they had that in common, that they were, at the time of their discovery, uninhabited by man or even by any large terrestrial mammal. There is not the slightest trace of evidence that any of the intervening lands or islands have ever been inhabited by them.

At first the Tortoises were found in immense numbers and of extraordinary size. Leguat (1691) says that in Rodriguez "you see two or three thousand of them in a flock, so that you may go above a hundred paces on their backs;" and indeed, when we consider that these helpless creatures lived for ages in perfect security from all enemies, and that nature has endowed them with a most extraordinary degree of longevity, so that the individuals of many generations lived simultaneously in their island home, we can well account for the multitudes found by the first visitors to those islands. For a period of more than a century they proved to be a source of great benefit to the crews and passengers of ships, on account of their excellent and wholesome meat. In times when a voyage, now performed in a few weeks, took as many months, when every vessel, for defence's sake and from other causes, carried as many people as it was possible to pack into her, when provisions were rudely cured and but few in kind, these tortoises which could be captured in any number with the greatest ease in a few days, were of the greatest importance to the famished and scorbutic ship's company. The animals could be carried in the hold of the ship for many months without food, and were slaughtered as occasion required, each tortoise yielding from 80 to 300 pounds of fresh wholesome food; and we read that ships leaving the Mauritius or the Galapagos used to take upwards of 400 of these animals on board.

Although no account of the first discovery of the Galapagos Islands appears to have been published, so much is certain that it is due to the Spaniards, who applied the Spanish word for tortoise to this group of islands. It became the regular place of meeting and refitting to the buccaneers and whalers, who provisioned themselves chiefly with tortoises and turtles. But numerous and constant as these visits were, the reckless destruction of animal life was limited chiefly to the coast-belt, and numbers of the animals inhabiting the interior escaped; no regular or extensive settlement being attempted, the condition of the islands and of the animals inhabiting them remained in the main unaltered until the earlier portion of the present century. From the accounts of that period I select that given by Porter, a Captain in the United States Navy, as the one which contains by far the most interesting observations (Journal of a cruise made to the Pacific Ocean, New York, 1822, 8°). He found, in the year 1813, the tortoises in greater or less abundance in all the larger islands of the group which he visited, viz., Hood's, Narborough, James, Charles, and Porter's Islands. On Chatham Island he found only a few of their shells and bones, which appear to have been lying there for a long time, and possibly may have belonged to individuals transported from some other island. On Albemarle Island, the largest of the group, none were observed by him, evidently because he landed here only for a few hours on the south-western point. Abingdon, Binloe's, Downe's and Barrington Islands were not visited by him. He describes the steps of the tortoises as slow, regular, and heavy; they carry their body about a foot from the ground, frequently erecting their neck, which is from eighteen inches to two feet long, and very slender; also their head is comparatively small. In the daytime they appeared remarkably quick-sighted and timid, drawing their head into the shell on the slightest motion of any object; but they are said to be entirely destitute of hearing, as the loudest noise, even the firing of a gun, did not seem to alarm them in the slightest degree. At James Island Porter took on board as many as would weigh about fourteen tons, the individuals averaging about sixty pounds, that is, about 500 individuals; and he states that among the whole there were only three males which he distinguished by their great size and by the greater length of the tail. As the females were found in low *sandy* bottoms, and all, without exception, were full of eggs, he presumed that they came down from the mountains for the purpose of laying; the few males had been taken at a considerable distance from the shore, in the hilly interior of the island. The eggs are perfectly round, white, with a hard shell of a diameter of 2½ inches. He found the blood of the tortoises to possess constantly a temperature of 62°, whilst the general temperature of the air in the Galapagos varies from 72° to 75°.

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* The substance of this article is contained in a paper read by the author before the Royal Society in June, 1874, which will appear in the forthcoming volume of the "Philosophical Transactions," and to which I must refer for the scientific portion and other details. Some facts which have come to my knowledge subsequently to the reading of this paper, are added.

Very significant are Porter's remarks as regards the differences of the tortoises from different islands. Those of Porter's Island he describes as being generally of an enormous size, one (not by any means the largest) measuring 5½ feet in length, 4½ feet in width, and 3 feet in depth. The form of the shell of the race inhabiting Charles's Island is elongate, turning up forward in the manner of a Spanish saddle, of a brown colour and of considerable thickness, whilst the tortoises of James Island are round, plump, black as ebony, and remarkably thin-shelled. The tortoises of Hood's Island, one of the smallest of the group, were small, and as regards form, similar to those from Charles's Island.

Twenty-two years had passed since Porter's Cruise, when Darwin visited the Galapagos Archipelago in the *Beagle*, in the year 1835. On his excursions in the interior he still met with large individuals, but a change by which the existence of these animals was much more threatened than by the visits of whalers, &c., had taken place. The Republic of Equador had taken possession of the Archipelago, and a colony of between two and three hundred people banished by the Government, had been established on Charles Island, who reduced the number of tortoises in this island so much that they were driven by necessity to send parties to other islands to catch tortoises and salt their meat. Also, pigs had multiplied and were roaming about in the woods in a feral state, no doubt destroying the offspring of those which hitherto had escaped.

After an interval of not quite eleven years H.M.S. *Herald* followed the *Beagle* on a voyage of discovery and survey. The naturalist of this expedition, which reached the Galapagos in the year 1846, found that the progress of civilisation had been great, or, in other words, that the displacement of the indigenous fauna by man and his companions had proceeded apace. On Charles Island the cattle had increased wonderfully, and were estimated at 2,000 head, beside wild pigs, goats, and dogs; the wild dogs keeping the goats and pigs very much down, whilst the tortoises had been exterminated between the visits of the *Herald* and *Beagle*. On the other hand, they were met with on Chatham Island, but the largest individual measured only two feet two inches in length.

Recent accounts of visits to the Galapagos do not give us the particulars of the present condition of the indigenous fauna, nor do they contain any information as regards the survivors of its Chelonians. The specimens which at rare intervals reach Europe *viâ* Panama, are young individuals not exceeding twenty inches in length or about twenty-five pounds in weight. The giants of their race appear to be extinct or nearly so, and it is scarcely to be expected that (except under most favourable conditions) any of the surviving comparatively young and small individuals of so slow-growing a form of animal life will be allowed, by an increasing lawless population, to live long enough to reach the dimensions of the individuals of former generations. Therefore, there is but little hope that valuable additions will be made to the scanty and incomplete material in our collections; and any information as regards the present occurrence of the several races in the various islands, is to be received with caution, as evidently the original distribution of the races has been much interfered with in the course of time by the carriage of tortoises from one island to the other.

The original condition and the fate of the tortoises of the Mascarene Islands were precisely the same as in the Galapagos. Their extreme abundance in the small island of Rodriguez * has been referred to above. Down to 1740 they continued to be numerous in the Mauritius; for Grant ("Hist. Maurit.," p. 194) writes in that year—"We possess a great abundance of both land- and sea-turtles, which are not only a great resource for the supply of our ordinary wants, but serve to barter with the crews of ships who put in here for refreshment on their voyage to India." But they appear to have been much more scattered in the larger islands than in Rodriguez; and, according to Admiral Kempinfeldt, who visited the latter island in 1761, small vessels were constantly employed in transporting these animals by thousands to Mauritius for the service of the hospital. Soon, however, their number appears to have been rapidly diminished; and to the causes which worked their destruction in the Galapagos, here another was added, viz., widely spreading conflagration, by which the rank vegetation of the plains was destroyed to make room for the plantations of the settler. They did not long survive the Dodo or Solitaire, and early in the present century the work of extermination was accomplished; there is at present not a single living example either in Rodriguez or Mauritius.

Our knowledge of the indigenous fauna of the Island of Réunion is still extremely meagre. If we can trust to tradition, a gigantic land-tortoise once inhabited this island; and if this be really the case, it must have become extinct long before the Mauritius and Rodriguez species, nor is there any evidence to show its affinity to one of the other races. The Seychelles do not appear to have been inhabited by these animals, certainly not within historical times, all the individuals found there having been imported from Aldabra and kept in a semi-domesticated condition.

The Island of Aldabra, the only spot in the Indian Ocean where this Chelonian type still lingers in a wild state in small and gradually diminishing numbers, lies in lat. 9° 25′ S., long. 46° 20′ E. In reality it consists of three islands, separated from one another by a deep channel about half a mile wide. They are covered with verdure, low tangled bushes interspersed with patches of white sand; two of the islands are rather low, hummocky near the centre. The middle island is slightly the largest, extending six or eight miles in length and three or four miles in breadth; it is much higher than the others, and partly covered with very high trees that may be seen eight or nine leagues from the deck of a moderate-sized ship.

ALBERT GÜNTHER

(*To be continued.*)

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* Again amply testified by the rich collection of tortoise-bones made by Mr. Slater, one of the naturalists appointed by the Royal Society to accompany the Transit of Venus Expedition to Rodriguez.

NOTES

AN attempt has been recently made to supply a great desideratum for naturalists residing in or visiting London, in a reading-room, in a central situation, where they may consult recent publications and current periodical literature, English and foreign. The Linnean Society has taken advantage of the excellent accommodation now afforded it in Burlington House, Piccadilly, to utilise its council-room for this object when not required for the purposes of the Society. The room is open from ten to six (or four on Saturdays) to Fellows of the Society and others properly introduced, and several tables are well supplied with the newest literature in the two branches of Biology, and others are furnished with accommodation for writing, &c. It is also in immediate proximity to the very fine library of standard works in natural history possessed by the Society, where the librarian is always in attendance. If we might make a suggestion to the Council of the Society for the further development of this very useful movement, it would be that means should be taken for a more prompt and regular supply of some of the leading foreign scientific journals, as, for instance, the *Comptes Rendus* of the French Academy, in which respect the reading-room of the Linnean Society still contrasts unfavourably with that of the Royal College of Surgeons; but the longer hours are a great advantage. The room ought to become the recognised *rendezvous* for naturalists in London.

THE Royal Horticultural Society has awarded Mr. Worthington G. Smith its Gold Banksian Medal for his discovery in connection with the potato disease which we recorded last week. We refer our readers to an article by Mr. Smith on the subject in this week's NATURE.

DR. R. B. WALKER, F.R.G.S., is on his way home from Gaboon (where he has resided for the last ten years) with the view of publishing his "Twenty-five years experience in Equatorial Africa." Extensively engaged in commerce and geographical research, and having visited all the principal colonies and stations on the West Coast, his contributions to our knowledge of the fauna and flora, anthropology, dialects, and natural products of commerce, ought to be valuable and certainly more trustworthy than those of transient visitors.

THE International Geographical Exhibition at Paris, which was opened on the 15th inst., promises to be a decided success. An immense number of visitors have already passed through the galleries, although several nations have not yet completed their preparations, and the annexes on the Terrace du bord de l'eau are far from being ready. The objects exhibited are classed into seven groups. Group 1 has to do with geographical mathematics, geodesy and topography, and the instruments pertaining to them. Group 2 deals with hydrography and maritime geography. Group 3 embraces physical geography, general meteorology, general geology, botanical and geological geography, and general anthropology. Group 4 is rich in ancient treatises, printed and in manuscript, on geographical subjects; fantastically-designed old maps, old instruments, ethnographic collections, and geographical dictionaries. Group 5 is devoted to statistics and to social, political, and agricultural economy. Group 6 has to deal with the teaching and diffusion of geography; and Group 7 with explorations, scientific and commercial voyages, and tours in search of the picturesque. The following are some of the objects which have proved most attractive to the public:—In the Salle des Etats, where the general meeting will be held, is the map of France constructed by the staff. This map is about sixty feet high by forty wide, and many people look at it with telescopes from a distance in order to find the details which interest them. In the English section is a large map of the polar regions, showing the route which the English expedition is to follow; also a large map of the Anglo-Indian Empire, the collection of the proceedings of the Royal Geographical Society and the magnificent instruments employed by the Indian Trigonometrical Survey. The American section, in a remote part of the building, is notable for the admirable collection of the maps of the U.S. Signal Office, and the physical atlas constructed by the venerable Prof. Henry. In the Russian department are exhibited the jewels of the Khan of Khiva; a large map of Asia showing the itineraries of 150 Russian explorers who have travelled in that part of the world during the last twenty years; specimens of the map of the frontier between Russia and China; specimens of the topographical maps drawn by officers during the last Khivan expedition; a map of the Oxus, showing the old tract of the stream when it sent its waters into the Caspian as well as into the Aral Sea; a magnificent map of the Aral Sea, and a collection of geodetical and meteorological instruments. In the French section an attractive object is the complete French station used in observing the Transit of Venus at Saint Paul by Mouchez, with several specimens of photographs of the transit. There is expected from Sweden a meteorite so large that it will have to be placed outside in the Terrace du bord de l'eau; also an artificial representation of the aurora borealis, which is likely to prove of great interest. Dr. A. B. Meyer will exhibit a manuscript map of his explorations in New Guinea. This will doubtless be of great interest to geographers, as it is the first map of that region which goes into detail.

WE learn from the *Scotsman* that a meeting of the General Committee appointed in Glasgow to make the necessary arrangements for the meeting of the British Association to be held at Glasgow next year, was held on Wednesday week. A letter from the assistant-secretary of the Association to Sir William Thomson was read by Prof. Young, and in the course of it the name of Prof. Sir R. Christison, of Edinburgh, was mentioned as president-elect.

THE Paris Academy of Sciences on Monday last elected Capt. Mouchez to fill the place in the Section of Astronomy vacated by the death of the late M. Mathieu. The contest was unusually severe, every member of the Academy having taken part in the vote. Capt. Mouchez obtained 33 votes, and M. Wolf 26; one vote was given to M. Tisserand, the Director or the Toulouse Observatory.

GENERAL regret will be felt at the death,—which took place on Sunday,—of Lady Franklin, at the age of 83 years. Jane Griffin, for such was her maiden name, was married to the great and unfortunate Arctic explorer on Nov. 5, 1828, and accompanied him almost constantly in the fulfilment of his duties until his departure on his last Arctic voyage of discovery in 1845. She has naturally ever since taken the deepest interest in Arctic exploration, and has herself directly done much to forward it by fitting out expeditions either entirely or partly at her own expense. It was she who sent out the *Fox* which in 1857–9, under Sir Leopold M'Clintock, did important service in Arctic exploration and in the discovery of the records and relics of the unfortunate Franklin expedition. That her interest in Arctic enterprise was strong to the very last is shown by the fact that she helped to equip the *Pandora* which so recently left our shores to attempt the N. W. passage under Captain Allen Young. For her services in this direction she received on the return of the *Fox* the Gold Medal of the Royal Geographical Society; she was the first woman on whom it was conferred, the only other one who obtained such a distinction being the late Mrs. Somerville. Until within the last few years, when incapacitated by old age and illness, Lady Franklin was herself an almost constant traveller; she had made a voyage round the world and visited many of the principal places in Europe, North and South America, Asia, and Australasia. She was, as might be surmised, a woman of superior intelligence, clear-sightedness, and great determination; her name will no doubt live alongside of that of her renowned husband.

FROM a circular letter of M. Leverrier to the Presidents of the Meteorological Commissions of the Departments of France, we learn that the "Atlas Météorologique" for the years 1872 and 1873 is in the press, and that concerted action of several departments by regions is, if slowly, yet gradually being inaugurated in different directions, particularly in the valleys of the Seine, Gironde, Rhône, and Meuse, and the Mediterranean sea-board. M. Fron resumes the discussion of thunderstorms, and M. Belgrand undertakes that of the rainfall.

IN connection with the recent disastrous inundation of the Garonne, the following heights, above low-water, of the floods of that river from 1804, as given by M. W. de Fonvielle in the *Bulletin Hebdomadaire* of the Scientific Association of France, Nos. 400 and 402, will be interesting:—July 1804, 21·7 feet; August 1809, 11·8 feet; May 1810, 21·8 feet; April 1812, 12·5 feet; June 1813, 17·8 feet; May 1815, 17·6 feet; April 1816, 16·7 feet; February 1817, 16·7 feet; November 1819, 10·9 feet; March 1821, 15·4 feet; May 1824, 16·4 feet; October 1826, 18·9 feet; May 1827, 23·3 feet; May 1830, 11·5 feet; October 1833, 17.4 feet; May 1835, 24·6 feet; March and April 1836, 13·1 feet; February 1839, 15·4 feet; April 1842, 17·1 feet; June 1845, 19·4 feet; February 1850, 18·4 feet; June 1853, 16·7 feet; June 1854, 18·0 feet; June 1855, 23·6 feet; and on the 24th June, 1875, 26·2 feet, the last being thus a foot and a half higher than any flood that has occurred in this valley during the past seventy-one years, and 3·3 feet higher than the historic flood of 1772.

PETERMANN'S *Mittheilungen* for July contain a map of Asia Minor, which by means of different colours shows the various levels of that region in metres. The map is, moreover, a useful one for general purposes, and is accompanied by a descriptive article by Freiherr v. Schweizer-Lerchenfeld.

THE same number of this Journal contains the continuation of Dr. Chavanne's valuable paper on the condition of the ice in the polar seas and the periodical changes to which it is subject. This paper is the result of a minute and careful examination of the reports of the most trustworthy observers, and contains two valuable tables, one showing the normal value of the winter and summer temperatures in fifteen of the principal polar basins, and the other the variation from the normal mean temperatures in summer and winter of the same basins for the period 1800–74. The paper is accompanied by a graphic chart illustrative of these tables, and also showing the secular variation in the condition of the ice in the Dwina at Archangelsk from 1734 to 1854, in connection with the secular variations in intensity of the Aurora Borealis from 1722 to 1870.

PETERMANN'S journal for August will contain a valuable paper by Dr. G. Nachtigal, giving a historical and descriptive account of the new Egyptian province, Dar Fur, and a brief sketch of the traveller's journey from Kuka to Khartoum. A map of the region referred to will accompany the paper, showing not only Nachtigal's route, but those of Von Heuglin and Schweinfurth.

IN connection with the Arctic papers of the Geographical Society, we recently referred to speculations on the condition of the interior of Greenland. The August number of the *Mittheilungen* will contain a paper by Dr. Rink on this subject, and on the possibility of crossing Greenland. The following are his principal conclusions:—1. The so-called interior ice is probably only a wall or rind, inside which may be found valleys free from snow and ice, and possibly even wooded. 2. All Greenland, probably, consists of a number of islands soldered together by the universal ice covering. 3. Most probably in two or three places, where the ice-fjords still disembogue, in earlier times a sound must have extended right across from the west to the east coast. 4. Glaciers and permanent snow are probably on the increase all over the land. 5. Floating icebergs are detached from the land by a sort of fall or downflow of the land-ice glaciers. Dr. Rink thinks that by means of properly constructed sledges drawn by men, and by carefully selecting a route and establishing suitable stations, the Greenland continent might be crossed from coast to coast.

WHILE so much is being done for Arctic exploration, the Germans in recent years have not been neglecting the exploration of the Antarctic seas. In 1873 the German Arctic Society of Hamburg, presided over by Albert Rosenthal, who has contributed so much to the equipment of polar expeditions, sent out an expedition to the south polar region under the command of Capt. Dallmann. Some of the results of this expedition will be found in the recently published expedition of Stieler's "Hand-Atlas," and a few details will be found in the August number of Petermann's *Mittheilungen*, especially with reference to Capt. Dallmann's exploration of Graham Land, discovered by the whaling Captain Biscoe, in 1832. Capt. Dallmann deserves credit for having added considerably to our knowledge of this hitherto little-known land. At the place where Biscoe saw nothing but what appeared a continuous coast line, Dallmann has discovered a strait from fifteen to eighteen nautical miles wide, with highlands between as far as the eye could reach, and an Archipelago of islands of about sixty nautical miles in extent, which has been named after Kaiser Wilhelm. Two other deep bays and many islands have been discovered and named, and will be found on the map already referred to.

THE prizes of the French Geographical Society have this year been awarded as follows:—A gold medal to Father Armand David, for his explorations in China and Mongolia; a gold medal to Dr. G. Schweinfurth, for his travels in North Africa; a silver medal to Abbé Émile Petitot, for his exploration of the North American region which extends from Great Slave Lake to the mouth of the Mackenzie; a silver medal each to MM. de Compiègne and Marche for their journey to the Gaboon and up the River Ogové; and the la Roquette gold medal to the family of the late Capt. Hall of the *Polaris* Arctic Expedition.

M. ADRIEN GERMAIN in the *Bulletin* of the French Geological Society discusses the propriety of having a common meridian for all nations, and comes to the conclusion that the French should decidedly not abandon the meridian of Paris as their first, as it presents all the advantages which a first meridian should have.

MR. E. W. PREVOST has succeeded Mr. Clowes as Science Master at Queenwood College, Stockbridge.

IMPORTANT changes are contemplated in the organisation of the French National University, as a new law has been adopted by the Assembly allowing, under certain conditions, the opening of free Universities.

WITH regard to Mr. Barrington's query in last week's NATURE (p. 213), relative to the sudden scarcity of blackbirds and thrushes, Mr. G. Lingwood, of Alnwick, writes that in the district where he resides, and with which he is well acquainted, there is no such scarcity. Mr. J. Preston, writing from Belfast, likewise testifies to their superabundance in that neighbourhood.

IN an octavo volume of some eight hundred pages, the U.S. Government has recently issued a handbook of the ornithology of the region drained by the Missouri River and its tributaries, entitled "Birds of the North-west, from the pen of Dr. Elliott Coues." There are no illustrations.

WE are glad to see that among the Supplementary Estimates just issued is a re-vote of 1,000*l.* for the Sub-Wealden Exploration.

ON Tuesday, the inaugural meeting of the Royal Archæological Institute took place at Canterbury.

A FINE male Chimpanzee, which has cut its front permanent incisors and its anterior true molars, has just been presented to the Zoological Society by Captain Lees, Governor of Lagos, West Africa.

THE recently issued part of Dr. H. G. Bronn's *Thierreich* contains an account of the lower jaw and the teeth in the different orders of the Mammalia, together with numerous excellent outline drawings of the skulls of the same groups.

MESSRS. LONGMANS are preparing for publication, in three volumes, copiously illustrated, a treatise on galvanism and electro-magnetism, by Prof. Gurtav Wiedemann, translated from the second German edition, with the author's sanction and co-operation, by G. Carey Foster, F.R.S., Professor of Physics in University College, London.

THE same publishers will issue in the autumn, a text-book of Telegraphy, by W. H. Preece, C.E., and J. Sivewright, M.A., forming one of their series of "Text-books of Science."

AMONG the works Mr. John Murray will publish during the ensuing season, the following will probably be found of interest to our readers:—"Habits and Movements of Climbing Plants," by Charles Darwin, F.R.S.—"Eastern Seas, Coasts, and Harbours," being the cruise of H.M.S. *Dwarf* in China, Japan, Formosa, and Russian Tartary from the Corea to the River Amur, by Commander B. W. Bax, R.N. This book will be illustrated by a map and engravings.—"A School Manual of Modern Geography," edited by Dr. William Smith.—"A Popular Account of Dr. Livingstone's Second Expedition to Africa; the Zambezi, Lakes Shirwa and Nyassa, with illustrations."—A new edition, being the twelfth, of Sir Charles Lyell's "Elements of Geology," in two octavo volumes; and "A Natural History of Mammals, including Man," by Prof. St. George Mivart, F.R.S., forming the first part of an introduction to Zoology and Biology.

IN yesterday's *Times* will be found an extremely interesting account from Australia of a Frenchman, Narcisse Pierre Peltier, of about thirty years of age, who has been living for seventeen years among the savages of Night Island, off the north-east coast of Queensland, in lat. 13° 10′ S., long. 143° 35′ E. He was left on the island by some shipwrecked sailors when twelve years old, was treated kindly by the savages, and soon became identified with them in every respect. He is recovering rapidly the use of his mother-tongue both in speaking, reading, and writing, though he still retains some marked characteristics of savage life. He has given much information concerning the ribe among whom he lived so long; their language does not seem to have anything in common with the Malay or with any of the Papuan dialects. If judiciously treated, Narcisse might be made to yield valuable material to the anthropologist.

THE additions to the Zoological Society's Gardens during the past week include two Suricates (*Suricata zenik*) from South Africa, presented by Mr. F. Ward; two Golden Eagles (*Aquila chrysaëtos*) from Scotland, presented by Lord Lilford; a Chinese Water Deer (*Hydropotes inermis*) from China, a Sumatran Rhinoceros (*Rhinoceros sumatrensis*) from Malacca, two Scarlet Ibises (*Ibis rubra*), a West India Rail (*Aramides cayennensis*), a Common Boa (*Boa constrictor*), a Tuberculated Lizard (*Iguana tuberculata*) from South America, deposited; three Spotted Tinamous (*Nothura maculosa*) from Buenos Ayres, and two Guiana Partridges (*Odontophorus guianensis*) from Guiana, received from Southampton; a Black-billed Sheathbill (*Chionis minor*) from the Kerguelen Island, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

SCIENTIFIC SERIALS

THE *Quarterly Journal of Microscopic Science* may, at the present time, be looked upon as the representative of the most modern phase of biological thought. The current number contains articles of much more than ordinary importance. The first is by Mr. F. M. Balfour, being "A comparison of the early stages in the Development of Vertebrates." The plate which accompanies the memoir is coloured in a particularly instructive manner, which illustrates the ultimate destination of the different elements of the cellular layers of the blastoderm. Mr. Balfour's observations are in favour of the blastopore becoming neither the mouth nor the anus of the adult animal, but of its cicatrix being a weak spot at which one or the other may subsequently be more easily formed than elsewhere. The gap between the observed structure of the developing amphibian and selachian is made more simple by the introduction of a hypothetical intermediate form in which the segmentation cavity is represented as if "it were sunk down so as to be completely within the *lower layer cells*," a condition not quite easy to comprehend. Many other very important theoretical points are discussed in this particularly interesting paper.—The second paper is a reprint from the Privy Council Reports, of Dr. Klein's observations on the pathology of sheep-pox.—Mr. W. H. Jackson describes and figures a new Peritrichous Infusorian, named *Cyclochaeta spongilla*, found in a sponge from the river Chirwell.—Mr. A. A. W. Hubrecht of Leyden makes "some remarks about the minute anatomy of Mediterranean Nemerteans," including notes on the dermal tissues, nervous system, &c., of species of *Meckelia*, *Polia*, *Lineus*, *Ommatoplea*, and *Drepanophorus* (n.g.)—Prof. Lankester publishes in full his observations read before the Linnean Society, "On some points in the structure of Amphioxus, and their bearing on the morphology of vertebrata." The exact homology of the atrial chamber and of the perivisceral cavity in the Lancelet has been a fruitful source of discussion, and Prof. Lankester's study of the question throws considerable additional light on the subject. The conclusions to which his investigations lead are "first that the peritoneal cavity of the vertebrate is the same thing as the coelom of the worm and of Amphioxus; second, that the earlier vertebrate ancestors (represented in a degenerate form by Amphioxus) developed epipleura, which coalesced in the median line postorally to form an atrium; third, that whilst Amphioxus retains this atrium in functional activity, the other vertebrata have lost it by *the coalescence* of its outer and inner bounding wall, respectively epipleura and somatopleura; fourth, that whilst the indications of the earlier historical steps of this process are suppressed in all craniate vertebrata at present investigated, yet the Elasmobranchs do continue to present to us an ontogenetic phase in which the somatopleura and the epipleura are widely separated; thus enclosing between them an epicoel (the atrium of amphioxus)."—Mr. F. R. Lewis writes on Nematode Haematozoa in the dog, closely allied to *Filaria sanguinolenta*, found in the walls of the aorta. These are figured, as are the parts of *Amphiporous spectabilis* and other Nemerteans, described by Dr. M'Intosh in considerable detail.—There is an admirable paper by Prof. Thiselton Dyer, containing a review of the various modes of sexual reproduction known among Thallophytes, with a sketch of the classification of that section of Cryptogams—including Algæ, Lichens, Fungi, and Characeæ—recently proposed by Prof. Sachs.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, June 23.[*]—Mr. John Evans, V.P.R.S., president, in the chair.—On the superficial geology of the Central Region of North America, by Mr. G. M. Dawson, Geologist to H.M. North American Boundary Commission.

Physical Geography of the Region.—The region under consideration is that portion of the great tract of prairie of the middle of North America from Mexico to the Arctic Sea, which lies between the forty-ninth and fifty-fifth parallels, and extends from the base of the Rocky Mountains to a ridge of Laurentian rocks that runs north-west from Lake Superior towards the Arctic Sea, and is called by the author the "Laurentian axis." This plateau is crossed by two watersheds; one, starting from the base of the Rocky Mountains at about the forty-ninth parallel, runs due east to the 105th meridian, when it turns to the south-east, dividing the Red River from the Missouri; the other crosses from the Rocky Mountains to the Laurentian axis near the fifty-fifth parallel. The whole region between these two transverse watersheds slopes gradually eastward, but is divisible into three prairie steppes or plateaus of different elevations. The lowest includes Lake Winnipeg and the valley of the Red River; its average altitude is 800 feet. The second, or the "Great Plains," properly so called, has an average elevation of 1,600 feet. The third or highest is from 2,500 to 4,200 feet above the sea, and is not so level as the other two.

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[*] Continued from p. 221.

Glacial Phenomena of the Laurentian Axis.—The neighbourhood of the Lake of the Woods is taken by the author as furnishing an example of the glaciation visible in many parts of the Laurentian axis. This lake is seventy miles long, and has a coast line of three hundred or four hundred miles. The details of its outline closely follow the character of the rock, spreading out over the schistose and thinly cleavable varieties, and becoming narrow and tortuous where compact dioritic rocks, greenstone, conglomerate, and gneiss prevail. The rocks both on the shores and the islands in the lake are rounded, grooved, and striated. The direction of the striæ is from north-east to south-west.

Drift Plateau of Northern Minnesota and Eastern Manitoba.—This plateau consists of a great thickness of drift deposits resting on the gently sloping foot of the Laurentian, and is composed to a depth of sixty feet or more of fine sands and arenaceous clays, with occasional beds of gravel and small boulders, probably reposing throughout on boulder-clay. The only fossil found was a piece of wood apparently of the common cedar (*Thuja occidentalis*). The surface of the plateau is strewn with large erratics, derived chiefly from the Laurentian and Huronian to the north; but there are also many of white limestone. The fossils in some of the latter being of Upper Silurian age, the author is inclined to believe, with Dr. Bigsby, that an outcrop of Upper Silurian is concealed by the drift deposits in the Lake of the Woods region.

Lowest Prairie Level and Valley of the Red River.—This prairie presents an appearance of perfect horizontality. The soil consists of fine silty deposits arranged in thin horizontal beds resting on till or boulder-clay. Stones were exceedingly rare. The western escarpment was terraced and covered with boulders. It is therefore probable that this prairie is the bed of a pre-glacial lake.

The *Second Prairie Plateau* is thickly covered with drift deposits, which consist in great part of local débris derived from the underlying soft formations, mixed with a considerable quantity of transported material, especially in the upper layers. Large erratics are in places abundant; they consist mainly of Laurentian rocks, but Silurian limestone also abounds. The following is the percentage of the boulders from the different formations present in the drift:—Laurentian, 28·49; Huronian, 9·71; Limestone, 54·01; Quartzite Drift, 1·14. The last is derived from the Rocky Mountains, the other three from the Laurentian axis. There are also on the surface of this plateau some remarkable elevated regions, apparently entirely composed of accumulated drift materials.

Edge of the Third Prairie Plateau, or the *Missouri Coteau,* is a mass of glacial débris and travelled blocks averaging from thirty to forty miles in breadth, and extending diagonally across the country for a distance of about 800 miles.

Third or Highest Plateau.—There is a marked change in the drift on this plateau, the *quartzite drift* of the Rocky Mountains preponderating, seldom showing much glaciation. Its general character may be seen from the following percentage of its composition:—Laurentian, 27·05; Huronian, ?; Limestone, 15·84; Quartzite drift, 52·10. Some of the lower parts of this steppe show thick deposits of true till with well-glaciated stones, both from the mountains and the east, and débris from underlying tertiary beds, all in a hard yellowish sandy matrix. On the higher prairie sloping up to the Rocky Mountains the drift is entirely composed of material derived from them.

The *Rocky Mountains* themselves show abundant traces of glaciation. Nearly all the valleys hold remnants of moraines, some of them still very perfect. The harder rocks show the usual rounded forms, but striation was only observed in a single locality, and there coincided with the main direction of the valley. The longer valleys generally terminate in *cirques,* with almost perpendicular rock-walls, and containing small but deep lakes.

State of the Interior Region of the Continent previous to the Glacial Period.—The author considers that previous to the glacial epoch the country was at about its present elevation, and that its main physical features and river-drainage were already outlined. Subaërial denudation had been in operation for a vast period of time, and an enormous mass of tertiary and cretaceous strata removed.

Mode of Glaciation and Formation of the Drift Deposits.—The author did not find any evidence rendering the supposition of a great northern ice-cap necessary, but suggests that local glaciers on the Laurentian axis furnished icebergs laden with boulders, which were floated across the then submerged prairies towards the Rocky Mountains.

On some important facts connected with the Boulders and Drifts of the Eden Valley, and their bearing on the theory of a Melting Ice-sheet charged throughout with rock-fragments, by D. Mackintosh. In this paper the main object of the author is to defend generally received opinions, especially as regards the great glacial submergence, in opposition to the theory announced in the Quart. Journ. Geol. Soc. for last February (vol. xxxi. p. 55). He brings forward a number of facts and considerations, founded on repeated observations, to show that the dispersion of Criffell granite-boulders is so interwoven with that of boulders of porphyry and syenite from the Lake-district as to be incompatible with the theory of transportation by currents of land-ice; and that the limitation of Criffell boulders along the S.E. border of the plain of Cumberland to about 400 feet above the sea-level is inconsistent with the idea of a boulder-charged ice-current 2,400 feet in thickness. His main argument against the theory of land-ice "charged throughout with rock-fragments of all sizes," is derived from the purity of the interiors of existing ice-sheets; and he quotes Prof. Wyville Thomson in support of his statements.

Observations on the unequal distribution of Drift on opposite sides of the Pennine chain, in the country about the source of the River Calder, with suggestions as to the causes which led to that result, together with some notices on the high-level drift in the upper part of the valley of the River Irwell, by John Aitken. The author, in calling attention to the unequal distribution of the drift on the opposite sides of the Pennine chain in this district, points out that on the western side of that range an extensive series of drift-deposits is found, spreading over the great plains of Lancashire and Cheshire down to the Irish Sea. It also occurs on the west flanks of the chain at elevations of from 1,100 to 1,200 feet, thus rising several hundred feet above the watersheds of some of the valleys penetrating that elevated region. On the eastern side, however, there is, with one or two slight exceptions, an entire absence of such accumulations, even in the most sheltered and favourable situations, for a distance of twelve or fifteen miles from the water-parting of the country. This absence of drift on the eastern side might, the author considers, be satisfactorily accounted for by supposing that the transverse valleys of the chain were, during the glacial epoch, completely blocked up with congealed snow or ice, by which means all communications between the opposite sides of the range would be entirely cut off. The southward flow of the ice, which was probably not so thick as to cover the higher portions of the chain, would, on encountering such an obstacle to its progress, be deflected westwards, and finally debouch into the plains of South Lancashire, and would there deposit on its retreat the débris it contained.—(*To be continued.*)

Geologists' Association, July 2.—Mr. Wm. Carruthers, F.R.S., president, in the chair.—On some of the causes which have contributed to shape the land on the North Wales border, by D. C. Davies. In a series of diagrams the author showed the probable results of an upheaving force acting upon different kinds of strata; and, in the second part of his paper, gave a detailed account of several instances, along the Welsh border, where important physical features now existing had been determined by faults and anticlinals. These were shown in a second series of diagrams in which the actual relation of numerous valleys, gorges, &c., to faults, &c., was pointed out. The various agents of erosion such as sea-water, rain-water, and ice had modified, and in some cases altered, the features due to disturbance; but the author claimed that a proper regard should be had to all the forces of nature, both internal and external to the surface in producing the contour as it now exists.—The Yorkshire Oolites, Part II., by W. H. Hudleston.

Entomological Society, July 5.—Sir Sidney Smith Saunders, C.M.G., president, in the chair.—Mr. Dunning remarked that the *Ornithoptera* bred by Mr. Sealy from larvæ taken at Cochin, South India, and exhibited by him at a recent meeting had been identified as *O. minos*.—Mr. Bond exhibited two specimens of a *Curculio*, sent from Nova Friburgo, Brazil, which were attached to the same twig and were both attacked by a fungus. Mr. Janson said that they belonged to the genus *Hylopus*, and were well known to be subject to such attacks.—The President exhibited a lock taken from a gate at Twickenham entirely filled with the cells of a species of *Osmia*, which Mr. Smith said was, most probably, *O. bicornis*, of which he had known several instances in locks. He also exhibited an example of the minute *Hylechthrus rubri*, one of the *Stylopidæ*, parasitic upon *Prosopis rubicola*, recently obtained from briars imported from Epirus, and remarked upon a method of expanding the wings of *Stylopidæ*. He also exhibited a series of *Halictus nitidiusculus*, stylopized, and recommended entomologists on the south coast to search in August for stylopized *Halicti*, especially among thistles. Finally, he remarked on the parasites of *Osmia* and *Anthidium*, and enumerated eleven insects attacking the same species of *Osmia* in its different stages—some devouring the egg and pollen-paste, some the larvæ, and others attacking the bee itself.—Mr. Champion exhibited a series of recently captured individuals of *Chrysomela cerealis*, from Snowdon, its only known British locality. Mr. M'Lachlan stated that he had recently seen this species in the Department of Saône-et-Loire, in France, in great numbers, each ear of wheat having several of the beetles upon it, and remarked on the singular nature of its sole habitat in Britain.—The Secretary exhibited nests of a trap-door spider, sent from Uitenhage, near Port Elizabeth, Cape Colony. The nests were not (as is usual) in the earth, but in cavities in the bark of trees; and the "trap-door" appeared to be formed of a portion of the bark, thus rendering it most difficult to detect the nests when in a closed condition.—Mr. Charles V. Riley, State Entomologist of Missouri, exhibited sundry insect pests that do so much damage in the State, including the Army-worm (*Leucania impuncta*), and the Rocky Mountain Locust (*Caloptenus spretus*), and entered at some length into the habits of the latter insect and the vast amount of destitution caused by it; stating that in a short period it devoured almost every living plant, leaving nothing but the leaves of the forest trees, and converting a fruitful country into an absolute desert. From a knowledge of the habits of the insect, and believing in its inability to exist in a moist climate, he had predicted that its ravages would not extend beyond a certain line, and he had seen these predictions fulfilled. Having noticed that hogs and poultry grew excessively fat from devouring locusts, and considering that the use of them as food for man would tend to relieve some of the distress occasioned in the devastated districts; he had caused a number of them to be prepared in various ways, and they were found to be well suited for food, especially in the form of soup.—Mr. Riley also stated that he was very desirous of taking a supply of cocoons of *Microgaster glomeratus* to America to lessen the ravages of the larvæ of the genus *Pieris* on that continent, and would be greatly obliged to any entomologist who could assist him in obtaining them.—The following papers were communicated:—Descriptions of new Heteromerous Coleoptera belonging to the family *Blapsidæ*, by Prof. J. O. Westwood.—Description of a new species of Myriopod, from Mongolia, by Arthur G. Butler.—Descriptions of new *Coleoptera* from Australia, by Charles O. Waterhouse.

PARIS

Academy of Sciences, July 12.—M. Frémy in the chair.—M. Chevreul communicated the fourth extract from his third memoir "on the explanation of numerous phenomena which are a consequence of old age."—Are the disasters caused by the hurricane of 1860 near Réunion referable to the laws of Cyclones? by M. Faye.—M. J. Bertrand called the attention of the Academy to a passage in the second edition of P. Secchi's work on the sun, and made some critical remarks thereon.—Note by M. G. A. Hirn relative to the memoir of M. Kretz on elasticity in moving machines.—Theory of perfect numbers, a memoir by M. J. Carvallo.—Magneto-chemical phenomena produced in rarefied gases in Geissler tubes illuminated by means of induced currents, by M. [illegible] describes the effect of magnets in modifying the spectra of certain elements and compounds. Determinations of the wave-lengths of these modified spectra have been made for chlorine, bromine, iodine; the chloride, bromide and fluoride of silicium, boric fluoride, hydrochloric acid, antimonious chloride, bismuthous chloride, mercuric chloride, and the two chlorides of tin. The light of sulphur and selenium is immediately extinguished on "making" the magnet. Oxygen does not undergo much change. Nitrogen is modified in the red and orange. The hydrogen tube showed the D line on "making" the magnet, the line instantly disappearing on breaking contact. The author explains this phenomenon by supposing that the gas is projected suddenly against the side of the tube on magnetisation and carries away sodium particles.—On the "square mirror," an instrument for tracing right angles on the earth, and for use in the rapid measurement of great distances, by M. Gaumet.—On fused boric acid and its tempering, by M. V. de Luynes. The hardness of this substance (between 4 and 5) is between fluor spar and apatite. The powdered glass combines energetically with water, the temperature of the mixture rising to 100°. The used acid poured on to a metallic surface gives rise to the formation of a vitreous plate, of which the lower surface is more expanded than the upper, producing in consequence a bending of the plate which is sometimes sufficient to rupture it. Poured into oil, the fused acid forms small tailed drops, which break under the same conditions as "Prince Rupert's drops." A plate of the boric acid glass, with parallel faces, acts on polarised light like "toughened" glass, but preserves its property under conditions which destroy the polarising power of glass. The fused acid, placed in water, undergoes hydration by laminæ producing a true exfoliation.—On the laws of the exchanges of ammonia between the seas, the atmosphere, and continents, by M. T. Schlœsing.—Description and analysis of a mass of meteoric ore which fell in Dickson County, Tennessee, by M. Lawrence Smith. Its composition is Fe, 91·15; Ni, 8·01; Co, 0·72; Cu, 0·06. Heated *in vacuo*, two volumes of gas were given off, composed of H, 71·04; Co, 15·03; Co_2, 13·03.—Planet 146 Lucine, discovered at the Observatory of Marseilles by M. Borrelly, June 8, 1875; ephemeris calculated by M. E. Stephan.—On the temporary magnetisation of steel, by M. Bouty.—Theory of storms; conclusions. A note by M. H. Peslin.—Estimation of carbon disulphide in the alkaline sulphocarbonates of commerce, by MM. Delachanal and Mermet.—On the preparation of tungsten and the composition of wolfram, by M. F. Jean.—On some new derivatives of anethol, by M. F. Landolph.—Researches on emetine, by M. A. Glenard.—Differential ophthalmoscopic signs of disturbance and contusion of the brain, by M. Bouchut.—Of the causes of the spontaneous coagulation of the blood on issuing from the organism, by M. F. Glenard.—On the hailstorm which burst over Geneva and the Rhône valley on the night of July 7–8, by M. Colladon.—On clouds of ice observed during an aërostatic elevation on July 4, by M. W. de Fonvielle.

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THURSDAY, JULY 29, 1875

PRACTICAL PHYSICS

WE propose in the present article to carry out the intention expressed in a former number (vol. xii. p. 206) of giving fuller details of the practical instruction in physics, which forms a part of the summer course of instruction given to science teachers by the Science and Art Department. The teaching of practical physics presents several difficulties, which have no doubt largely militated against its general introduction into the course of scientific education. It has not yet been systematised. Unlike practical chemistry one cannot select a practical text-book on physics and give it to the students; for such text-books do not yet exist in English. We are not forgetting the translation of Weinhold's Experimental Physics, which we lately reviewed in these columns; but that book is unsuitable for most students owing to its unwieldy size and high price.

Even if works on practical physics were at hand, another difficulty is encountered in the costly nature of the apparatus involved in studying physics. This no doubt is one of the main difficulties that the teacher has to overcome, and in this respect physics differs widely from chemistry, for it is out of the question to provide a complete set of physical apparatus for every two or three students. To meet this difficulty one may distribute different instruments among the students and allow them in turn thoroughly to master what is put before them. This plan might do for a small class, the members of which could use their fingers already. But it is at best an unsatisfactory method, for it leaves the student completely at sea directly he begins to communicate the instruction he has received, unless he can purchase what he has been in the habit of using, and this is not often within his means to do. Another course is first to teach the students how to make simple apparatus for themselves, and then to show them how to use it. The advantages of this plan are apparent. Students unaccustomed to manipulation find to their astonishment, when they begin, that all their fingers have turned into thumbs, and are amazed at their clumsiness and stupidity. Very soon, however, fingers begin to reappear, and the first successful piece of apparatus that is made gives them a confidence in themselves which they had thought impossible to attain. The pleasure of having made an instrument is increased a hundredfold when it is found that by their own handiwork they may verify some of the more important laws in physics; or make physical determinations, which before they would have considered it presumption to attempt, even with ready purchased apparatus. In order to carry out this plan successfully, minutely detailed instructions must be given to each student concerning the construction of the apparatus he has to make, and it is moreover obvious that the instruments should not take too long to make, and that the first trials should be with the simplest apparatus possible.

Let us now look at the science teachers at work at South Kensington. Each one has given to him a page of printed instructions for the day's work. These instructions have grown up within the last few years under the direction of those who have been associated with Dr. Guthrie in this undertaking, namely, Professors G. C. Foster and W. F. Barrett, together with the valuable aid of Mr. W. J. Wilson.

In the teaching of Practical Physics perhaps no subject lends itself more readily to practical work than Electricity and Magnetism; and as nearly every science student has had some little practice in this direction, this branch of physics commends itself as best fitted to begin with.

The first day's work on Electricity and Magnetism commences with the construction of simple electrical apparatus, as for example "Make a glass tube for electrical excitation;" then comes what to do in the way of cutting the tube and closing the ends. This introduces some to their first experience with the blow-pipe and the manipulation of glass, in which they rapidly gain courage and proficiency.

After this they are told to make a balanced glass tube as follows:—

> "Glass tube about 12 inches × ¾ inch. Clean and dry inside, close and round one end, nearly close other end. Balance on edge of triangular file, mark centre with file. Soften one side of tube at centre with Bunsen burner, push in side with point so as to make conical cap. Avoid having file scratch at apex of cap."

Rubbers, pith balls, proof-planes are made, and the fundamental laws of electricity are tried before the day is over. Next day a gold leaf electroscope has to be made, and some capital instruments of this kind are turned out. The insulation of these electroscopes is so high that we have seen them retain a charge for an hour or more when the body of the instrument was standing in water. The secret of the insulation consists in using clean flake shellac; a little of this substance is melted in the hole through which the wire stem of the instrument has to pass, the stem is then warmed and pushed through the shellac so as to leave about a quarter of an inch thickness of shellac all round the wire. Without attempting to follow each day's work, we notice in passing that the distribution of electricity is tried by using card-board cones and cylinders covered with gilt paper, a Leyden jar with movable coatings is constructed, an electrophorus is made and various experiments tried with it, and even a Thomson's quadrant electrometer is among the more ambitious pieces of apparatus that are attempted.

Omitting Magnetism, which is not so fully developed as the other subjects, we come to Current Electricity. One of the first things that has now to be made is an astatic galvanometer, which occupies the greater part of one day's work. This instrument works so well, that for the sake of other science students we quote the following instructions for making it:—

> "Wind about 50 feet of fine covered copper wire on wood block; remove wood; secure coil by tying with thread; insulate and stiffen coil by soaking with melted paraffin or shellac varnish. Make another similar coil; fix the two coils side by side on round wood block, leaving about ¼ inch space between them and soldering two of the free ends of coils together so as to make one continuous coil. Solder other two ends of wire to binding screws fixed about ½ inch from edge of block. Lead ends of the wire also into two little hollows cut in wood block by side of binding screws, so that these depressions may serve as mercury cups; they are convenient for shunting

the galvanometer. Bend stout brass wire into flat-topped arch and fix firmly in block; the straight portion of wire at top of arch having upon it a cork roller for raising or lowering needles. Magnetise two sewing needles and fix (with opposite poles adjoining) ½ inch apart by means of twisted fine copper wire. On same axis, ¼ inch above upper needle, fix glass thread about 4 inches long to serve as pointer. Suspend needles by silk fibre and attach fibre to cork roller. Cut card into circle 4 inches diameter and graduate circumference into degrees. Place (but do not fix) card in proper position over coil, supporting it on two corks cemented to board. Make needles as far as possible astatic. Place them in position and cover all with glass shade."

After some preliminary work with the galvanometer, a Daniell's cell and a simple form of Wheatstone's bridge are made; then a rheochord and a set of resistance coils. Then comes the following work with these instruments, in each case the necessary instructions being printed under the work to be done:—

"1. Measure relative resistances of different lengths of the same copper wire by Wheatstone's Bridge. 2. Find lengths of copper wires by measuring their relative resistances, the length of one of the wires being known. 3. Ascertain relation between resistance and weight. 4. Ascertain effect of temperature on resistance. 5. Experimentally establish the laws of divided circuits. 6. Measure the external resistance of your cell. 7. Compare the electromotive force of your cell with that of a Grove's cell."

In this direction there is, of course, an almost unlimited field for practical work, but other parts of the subject claim attention, and the time that can be given to the whole is extremely limited. Our space will not allow us to detail further what is done in electricity, nor can we give more than a hasty glance to the other subjects that are taken up in successive years by the science teachers.

Sound is not a very promising branch of Physics for practical work; nevertheless, nine or ten days are usefully spent on this subject. A monochord is the *pièce de résistance* here, and when this is made the laws of the transverse vibration of strings are verified, and the following problems solved by its means:—"1. Weigh pieces of metal of unknown weight. 2. The pitch of one tuning fork being known, ascertain that of another unknown. 3. The diameter of a German silver wire being known, ascertain its specific gravity." By means of the ordinary shilling tuning forks some useful experiments are made, and finally the velocities of sound in various solid, liquid, and gaseous bodies are determined in different ways and with a satisfactory approximation to the truth. This will indicate merely the course of practical work in sound.

Heat and Light offer more facilities for practical work. In Heat, a differential air thermometer is first made, then an alcohol thermometer is determined and graduated; the maximum density of water is tried by simple hydrometers; a bulb tube is made, and here we quote two experiments in which this bulb is used for determining coefficients of expansion:—

"Determine mean Coefficients of absolute expansion of Water and Alcohol between temperature of the day and 50° C. above.

"Weigh bulb tube filled with liquid at temperatures t and T. Calling weight of liquid at t, W and loss of weight at T, w, the Coefficient of apparent expansion is $\frac{w}{W - w}$. The real expansion is obtained by adding to this the Coefficient of expansion of the glass. (See next experiment.)

"Determine mean Coefficient of expansion of glass of thermometer tubing for 50° C. above the temperature of the day.

"Weigh bulb tube full of mercury at temperatures t and T, and so obtain Coefficient of apparent expansion of mercury ($= B$). Then assuming Coefficient of real expansion of mercury as ·00018 ($= C$), $C - B$ = mean Coefficient of glass."

The determination of specific and latent heat follows this, and a few experiments on radiant heat conclude this part.

In Light a large range of subjects is available for practical work, but the necessary instruments are more numerous, and require rather more skill in their manufacture. Nevertheless several experiments will occur to every teacher which can be made with very little preparation, such, for example, as trying the law of inverse squares, comparing in various ways the illuminating powers of different sources of light, &c. Here is something rather more difficult:—

"Make an instrument for measuring vertical heights by reflection." Instructions for this are given, and the instrument is then used for measuring the heights of ceilings, doors, &c., after it has been fully explained.

Silvering solutions are prepared and employed for many purposes; little concave and convex mirrors, for example, are made out of large watch-glasses silvered by this process of deposition, and the foci of these mirrors are then determined. A movable model is made to illustrate the law of sines; and the index of refraction of water is determined as follows:—

"Graduate slip of glass about 8 C.M. × 1 C.M. to M.M. Fix with sealing-wax two equal slips about 4 C.M. long at right angles to scale thus |——|. Place in water so that uprights are just below surface. Fix an eye-tube (blackened inside) at some distance above water and in line of scale, and note division at which top of nearest upright appears on scale. Now carefully withdraw water without disturbing apparatus, and again note division. Let height of upright be H, and distances on scale from upright respectively a and A, then $\frac{A}{H}$ = tangent of angle of incidence, and $\frac{a}{H}$ = tangent of angle of refraction. From tangent calculate sines, using formula sine $\theta = \frac{\tan \theta}{\sqrt{1 + \tan^2 \theta}}$. Index of refraction $= \frac{\text{Sine of angle of incidence.}}{\text{Sine of angle of refraction.}}$ Verify result by varying angles."

A bisulphide of carbon lens is made from two watch glasses with ground edges, a notch being cut across to introduce the liquid. A bisulphide of carbon prism is not so easy to make; here is the method recommended:—

"Cut-off and grind ends of glass tube about 2 inches long × ¾ inch diameter so that planes of ends make an angle of about 60° with each other. Drill hole about ⅛ inch diameter in middle of tube with hardened point of triangular file and turpentine. Glue pieces of thin sheet glass on ends. Fill with Bisulphide of Carbon and cover hole with glued paper."

By degrees a spectroscope is entirely built up, and with it the spectra of various metallic vapours are examined till some familiarity is acquired with different spectra. Finally, a polariscope is made and different objects for examination are devised. Our space is more than exhausted, and we cannot follow the teachers further in their work. Time will, no doubt, bring greater experience and improve an already admirable course.

As we remarked in a former article, the good work done by the Department must sooner or later indirectly affect all classes. We trust the time is not far distant when the pressure of public opinion will lead men and women alike to feel but half educated if they have no acquaintance with the living facts and solid ground of nature. The happy results of such a change will soon become apparent. Already, indeed, society is becoming more interested in science. Some knowledge of the methods and results of scientific inquiry is penetrating the population. New habits of thought and modes of reasoning are spreading widely. A juster estimate of the position of the scientific explorer is being held. At the same time a truer knowledge of nature is diffusing more profound and doubtless more reverent conceptions of the orderly mystery that surrounds us.

CARUS AND GERSTAECKER'S "HANDBUCH DER ZOOLOGIE"

Handbuch der Zoologie. Von Jul. Victor Carus und C. E. A. Gerstaecker. (Leipzig: Engelmann.)

THE second volume of this work appeared in 1863, the first part of the first volume in 1868, and at length the book is completed by the appearance of the second part of the first volume in 1875. It is somewhat late in the day to review the earlier parts of the undertaking, but looking at it as a whole, we do not hesitate to say that the "Handbuch" in which Prof. Carus has had the chief share (the Arthropods alone are treated by Prof. Gerstaecker) is eminently useful and worthy of his high reputation for perspicacity and practical good sense. There are few men to whom zoologists both in this country as well as in his fatherland, are so much indebted for solid help in their labours of research or of instruction as to Prof. Victor Carus. Who has not felt grateful to him for the "Bibliotheca Zoologica," which bears his name? What naturalist of this generation has not consulted, as a storehouse of inexhaustible treasure, the "Icones Zootomicæ," which, after twenty years, continues to hold its place as the most valuable pictorial treatise on the Invertebrata which we possess? Prof. Carus has further served his countrymen by acting as the competent translator of Mr. Darwin's works—and to us he has lent timely aid by discharging for two years the duties of the Edinburgh chair of Natural History in the absence of Prof. Wyville Thomson. In an enumeration of the labours of this kind for which zoologists have to thank Prof. Carus, we must not omit the volume on the history of Zoology—published in the Munich series of histories of the sciences—a work which is full of the most interesting details of the early beginnings and strange developments of the study of animal form.

It will not be out of place, whilst strongly recommending this book to the reader as a most trustworthy, succinct, and withal ample exposition of the facts of animal morphology in especial relation to the "system" or classification of the Animal Kingdom—to say a few words as to its method and order of treatment. The first volume (that most recently published) contains the Vertebrata, the Mollusca, and Molluscoidea. The second volume treats of the Arthropoda, Echinodermata, Vermes, Cœlenterata, and Protozoa. The groups of the animal kingdom are thus discussed in a descending order, beginning with the highest: at the same time each section treating of a subkingdom is complete in itself. The section of the work treating of any one sub-kingdom starts with a brief definition of the group of some ten or fifteen lines in length. Then follow several pages treating of the characteristic disposition of the various organs and their variation in the following order, (1) general form, (2) integument, (3) muscular system, (4) skeleton, (5) nervous system, (6) organs of sense, (7) digestive canal, (8) respiratory organs, (9) vascular system, (10) urinary and generative organs, (11) development, metamorphoses and reproduction of parts, (12) geographical and geological distribution, (13) chief systems of classification hitherto proposed, with an outline of the classification adopted by the author, brief definitions (about ten lines each) of the classes being introduced. After this we have the detailed consideration of each class, the highest being taken first. The same method is adopted in the exposition of the characters of the class as in the treatment of the sub-kingdom—as much as twenty-four pages being thus devoted to the class Mammalia. To the class follows an enumeration of its orders, each order being *briefly* characterised in the list and then taken in turn, the highest first, for more detailed treatment. Some additional facts with regard to each order beyond those introduced in the brief definition are given when it is thus taken in its turn, and under it are placed in succession with their characteristics briefly stated, the families and sub-families and genera, the enumeration of the latter being *complete.* The principal genera are characterised—referred to their authors whilst synonyms and sub-genera are indicated. The work goes so far into detail as to cite under the genera many of the commoner or more remarkable species—with a statement of the geographical and geological distribution of the genus. After the description of an order or other large group, we usually find a bibliographical list referring the reader to the more important monographs relating to the particular group. Thus the "Handbuch" furnishes us—within the limits which are possible in an ever-growing science—with a treatise on comparative anatomy, combined with an exhaustive enumeration of the genera hitherto distinguished by zoologists, referred to a definite place in a scheme of classification. As the latest complete systematic treatise on the Animal Kingdom, and one executed with the exercise of most conscientious care, and a very exceptional knowledge of the vast variety of zoological publications which now almost daily issue from the press—this work is one which is sure to render eminent service to all zoologists. We can speak to the usefulness of the earlier volume, from an experience of some years, and there is every reason to believe that the one just completed will be found as efficient.

Having said thus much in favour of the "Handbuch," we shall proceed to point out some of its shortcomings, which are rather theoretical than practical. Prof. Carus suffers in this book as in his "History" of Zoology, from the unphilosophic conception of the scope and tendencies of that division of Biology, which its early history has forced upon modern science. In England our newest and most conservative University continues to draw a broad distinction between what is called Comparative Anatomy and what is called Zoology. By some accident Zoology is the term which has become connected with the special work of arranging specimens and naming species which is carried on in great museums, and which has gone on in museums since the days when "objects of natural history," and other curiosities, first attracted serious attention in the sixteenth century. Accordingly Zoology, in this limited sense, has taken the direction indicated by the requirements of the curators of museums, and is supposed to consist in the study of animals not as they are *in toto*, but as they are for the purposes of the species-maker and collector. In this limited Zoology, external characters or the characters of easily preserved parts which on account of their conspicuousness or durability are valuable for the ready discrimination of the various specific forms—have acquired a first place in consideration to which their real significance as evidence of affinity or separation does not entitle them. From time to time the limited zoologists have adopted or accepted from the comparative anatomists hints or conclusions, and have worked them into their schemes of classification. But it does seem to be time in these days, when pretty nearly all persons are agreed that the most natural classification of the Animal Kingdom is that which is the nearest expression of the Animal Pedigree, that systematic works on Zoology should be emancipated from the hereditary tendencies of the old treatises, and should present to us the classes and orders of the Animal Kingdom defined not by the enumeration of easily recognised "marks," but by reference to the deeper and more thorough-going characteristics which indicate blood relationships. We have to note in the "Handbuch" the not unfrequent citation of superficial and insignificant characteristics in the brief diagnoses of taxonomic groups, which seems in so excellent a work to be due to a purposeless survival of the features of a moribund zoology that would know nothing of "insides," and still less of the doctrine of filiation. For instance, the very first thing which we are told of the Vertebrata in the short diagnosis of the group, is that they are "animals with laterally symmetrical, elongated, externally unsegmented bodies;" of the Fishes, that they have the "skin covered with scales or plates, seldom naked;" of the Mollusca, that they have a "laterally symmetrical, compressed body devoid of segmentation, often enclosed in a single (generally spirally-twisted) or double calcareous shell." It would be unjust to suggest that Prof. Carus, who long ago did so much to establish zoological classification on an anatomical basis, is not fully alive to the necessity, at the present day, of taking the wide biological view of animal morphology; but certainly the form in which parts of the book are cast, savours of the past epoch. It may be said that the object of the book is to present the "facts" of Zoology in a logical order; and that this sufficiently explains the arrangements to which objection might be taken as above, viz. the commencing with the higher instead of the lower groups, the prominent position assigned to external and little-significant characters, the absence of any recognition of the leading doctrine of modern Zoology, the doctrine of filiation. To this there is nothing to say excepting that of the very *many* logical methods of treatment possible in a handbook of Zoology, many are easy to follow out, and that one, which aims at presenting a logical classification of the kind spoken of by Mill, in which objects "are arranged in such groups, and those groups in such an order as shall best conduce to the ascertainment and remembrance of their laws," is a very difficult one to follow out. This kind of classification involves nothing less than an attempt (however inadequate) to trace the Animal Pedigree; for the laws to be ascertained and remembered are the laws of Heredity and Adaptation. We may regret then that so able a zoologist as Prof. Carus has remained in the old grooves and not ventured on to the inevitable track where Gegenbaur and Haeckel have preceded him.

It is in the same spirit that we draw attention to one or two features in the logical—or as it is sometimes called "objective"—classification adopted by Prof. Carus. He recognises the Molluscoidea as a main division of the Animal Kingdom, and places in it besides the Brachiopoda and the Bryozoa, the Tunicata. It certainly does not seem likely that in the present year (which is that which gives date to the volume containing the Molluscoidea) he would, if attempting to indicate genealogical affinities in his classification, do what he does whilst working on the old lines, namely, place the Ascidians in association with forms so remote from them as it now appears are the Brachiopods, and separate them so entirely from their blood-relatives among Vertebrates.

It is also interesting to note how the desire to frame symmetrical groups which can be easily defined in a few words, and on the other hand the desire to mark the gaps and the relative development of the branches of the genealogical tree, operate so as to lead individuals influenced respectively by one or other of those desires to propose very different changes in commonly accepted classifications. Both methods may have their use to-day, but we cannot shut our eyes to the fact that the motive in all classifications for the future must be *genealogy*. The changes proposed in J. Müller's classification of Fishes, respectively by Carus and by Haeckel, exhibit well the divergence of the tendencies of the "formal" (we cannot grant them the monopoly of the word "logical") and of the "genealogical" school. Dr. Günther of the British Museum is followed by Prof. Carus in his proposal to reduce Johannes Müller's six sub-classes of Fish, viz. Dipnoi, Teleostei, Ganoidei, Selachii, Cyclostomi, Leptocardii, to four, by the fusion of the Dipnoi, Ganoidei, and Selachii. The discovery of the Australian Ceratodus, which does not possess a special aortic branch distributed to the incipient lungs, and is different from Lepidosiren and Protopterus in the structure of its aortic bulb and its limbs, has been made the occasion for this logical or rather formal simplification. On the other hand, Prof. Haeckel wishing to show the large gap—the long series of intermediate forms—which *must* have intervened between the development of certain of the branches of the pedigree recognised by J. Müller as sub-classes of Fish, and wishing to express the *relative* distance of these branches from one another has, first of all (and we think with no exaggerated estimate of the gap to be marked out), removed the Leptocardii altogether from association with the other fish, and not only from association with them but from association with the remaining classes of Vertebrates. They stand alone as the group Acrania, whilst the remaining Vertebrata are the Craniata. The five remaining groups of Müller's fishes find their place with the Craniata, but one group is separated within that large division as having no jaws, no limbs, and an unpaired nostril; these are the Cyclostomi, which are placed by Haeckel apart from all the remaining Craniate Vertebrates. The steps of structural differentiation which must be passed through to connect the Lampreys with the lowest of the remaining groups of J. Müller's Pisces seems to warrant this. They, the Dipnoi, Ganoidei, Selachii, and Teleostei, all belong to the large division of the double-nostrilled, jaw-bearing Craniata; but Haeckel cannot feel that the logic of his method is fully carried out, if he does not mark more emphatically the divergence of the structural characters of Dipnoi from those of the remaining and dominant classes of Fish. The class of Fishes is restricted to the three sub-classes of Selachii, Ganoidei and Teleostei; of which the first are the nearest representatives of the common ancestors of the Ganoidei and Teleostei, whilst the Dipnoi form a separate class of the Gnathostomous Craniate Vertebrata, reaching well forwards in the direction of the Amphibia, which were derived from Palæozoic Dipnoi, these in turn having been derived from Ganoidei. No doubt, it would not be possible to make any distinction between the ancestral Ganoidei and Dipnoi of Palæozoic times, had we them all before us; but that is no reason why, in framing our classifications, we should not use such breaks and divisions of groups as will best indicate in the tabular form the branching relationships of these and neighbouring organisms. The consideration of a case like the one just discussed renders it very obvious that the whole method and point of view of the naturalist who attempts to make classification the expression of the most important laws of organic structure, and therefore a genealogy, is different from that of the naturalist who endeavours to make his groups as few as may be convenient, and such that a large number of propositions can be affirmed with regard to them. The work of the latter is marred by adhesion to a conventional form, that of the former is inspired by a life-giving theory.

The absence of illustrations to Prof. Carus's "Handbuch" is not to be considered as a deficiency. In the first place, adequate illustration would immensely increase the price of the work; in the second place, we have already the "Icones," which may serve excellently as an atlas for much of the second volume. What we want now from Prof. Carus is another volume of "Icones," to contain illustrations of the Vertebrata.

E. RAY LANKESTER

OUR SUMMER MIGRANTS

Our Summer Migrants. By J. E. Harting, F.L.S., F.Z.S. (Bickers and Son, 1875.)

AMONG the many detailed differences between the lives of country and town residents there is one which has a marked influence on the lines of thought adopted by each. The townsman as a rule finds that his numerous avocations—more numerous as they must be to enable him to survive in the severer competition for a livelihood that is associated with the extra expense involved in a non-rural life—give him but little time or need for simple physical exercise as such. He has to form his ideas of the outside world by noting, as he passes through various thoroughfares, such things as attract his attention whilst he is on his way from one duty to another. When his work is over, his great idea is rest. The animated creation, humanity excepted, is a sealed book to him. The case of the country resident is very different. Either his slow-moving occupation in the open air allows him ample opportunity for looking around him, or he is compelled to "take a walk" in order to overcome the injurious influence of a sedentary employment. The charms of scenery soon, from frequent repetition, lose much of their fascination, and the observation of the surrounding changes continually occurring in the animated world become the chief objects of attraction. Of these none are more interesting than the movements of the birds, especially of those species which, instead of taking up their continuous abode with us, only condescend to visit our shores during those seasons of the year which best suit their delicate constitutions. These, our summer migrants, form the subject of the work before us; one which will be particularly attractive, as here presented, to all who have any predilections towards ornithology or the observation of natural phenomena, both on account of the valuable information it contains and the particularly elegant way in which, both typographically and as far as binding is concerned, the book has been brought out, and Bewick's accurate engravings have been reproduced.

Mr. Harting's object has not been to write a systematic work on the subject for beginners, but to collect the results of his own and other more recent observations, both as to the exact dates of arrival and departure of the migratory species of our avifauna, as well as attested facts with reference to the localities which they inhabit as their winter-quarters. Prof. Newton's new edition of "Yarrell's British Birds," Colonel Irby's "Ornithology of the Straits of Gibraltar," and the investigations of the late Mr. Edward Blyth, are amongst the most important sources from which the author is enabled to collect the observations which he classifies and employs so as to make them of special interest with regard to each individual species.

The controversy, not long ago revived, and carried on partly in this journal during 1869 and 1870 by Prof. Newton, concerning the eggs of the Cuckoo, makes the chapter devoted to that bird of special interest. On the subject of whether the hen bird is in the habit of always laying her eggs in nests of the same species of foster parent, Prof. Newton remarks (NATURE, vol. i. p. 75), "without attributing any wonderful sagacity to the Cuckoo, it does seem likely that the bird which once successfully deposited her eggs in a Reed Wren's, or a Titlark's nest (as the case may be) when she had an egg to dispose of, and that she should continue her practice from one season to another. We know that year after year the same migratory bird will return to the same locality, and build its nest in almost the same spot. Though the Cuckoo be somewhat of a vagrant, there is no improbability of her being subject to so much regularity of habit, and indeed such has been asserted as an observed fact. If, then, this be so, there is every probability of her offspring inheriting the same habit, and the daughter of a Cuckoo which always placed her egg in a Reed Wren's or a Titlark's nest doing the like." To this Mr. Harting very justly replies—"This would be an excellent argument in support of the theory (of Dr. Baldamus) were it not for one expression, upon which the whole value of the argument seems to me to depend. What is meant by the expression 'Once successfully deposited?' Does the Cuckoo ever revisit a nest in which she has placed an egg and satisfy herself that her offspring is hatched and cared for? If not (and I believe such an event is not usual, if indeed it has ever been known to occur), then nothing has been gained by the selection of a Reed Wren's or Titlark's nest (as the case may be), and the Cuckoo can have no reason for continuing the practice of using the same kind of nest from one season to another." Mr. Harting therefore rejects the application of this principle in the case of the Cuckoo. We will suggest to him a modification of Prof. Newton's argument which may perhaps lead him to return to it in its modified form. The assumption that the bird which once successfully deposited her eggs in a Reed Wren's or Titlark's nest, would again seek for one of the same species in other seasons because of her *sagacity*, or her knowledge of its successful hatching, is highly improbable in our estimation, and not essential for the subsequent deductions, in a Darwinian point of view. It is more logical to suppose that ancestral Cuckoos deposited their eggs broadcast. That those which got into Reed Wren's and Titlark's nests (as in instances) all, or nearly all, hatched out; whilst those deposited elsewhere perished. The young *inherited* those peculiarities of the mother birds whose tendency was towards the utilisation of the Reed Wren's and Titlark's 'nests, and as a result the modern Cuckoo tends to place its eggs in those nests.

The evidently genuine sketch made by Mrs. Blackburn of the nestling Cuckoo ejecting the young of the Titlark along with which it was hatched, first published in the introduction to Gould's "Birds of Great Britain," is introduced as confirmatory evidence in favour of this, to the foster-brethren, murderous propensity of the young birds, with reference to which so many naturalists are still sceptical.

The peculiarity in the distribution of the Nightingale in this country is difficult to explain, especially as the Wryneck keeps within nearly the same boundaries. "When we find this bird in summer as far to the westward as Spain and Portugal, and as far to the northward as Sweden, we may well be surprised at its absence from Wales, Ireland, and Scotland; and yet it is the fact that the boundary line, over which it seldom if ever flies, excludes it from Cornwall, West Devon; part of Somerset, Gloucester, and Hereford; the whole of Wales (*a fortiori* from Ireland), part of Shropshire, the whole of Cheshire, Westmoreland, Cumberland, Durham, and Northumberland." From these data it is not difficult to recognise that with but few exceptions the Nightingale only visits those parts of this country which are covered with secondary or tertiary geological formations; and it has always seemed to us that it must be that the primary soils do not produce food suitable for the insects on which it feeds. It is true that the new red sandstone is the soil of Cheshire, and that much of Yorkshire and Derbyshire are primary formations, nevertheless the two boundaries are so similar in other respects that it is hardly possible that there is no relation between them.

There is another disputed point to which the author more than once alludes. He remarks that "we cannot help thinking that the Nightingale and many other birds which visit us in summer and nest with us, must also nest in what we term their winter-quarters; otherwise it would be impossible, considering the immense number which are captured on their first arrival, not only in England, but throughout central and southern Europe, to account for the apparently undiminished forces which reappear in the succeeding spring." The late Mr. Blyth was of an opposite opinion, and further observations are necessary before this question can be settled.

Besides the information given on subjects like the above, the nest and eggs of all the species, fifty in number, are described; whilst exact measurements are included of closely allied forms, such as the Wood Warbler, the Willow Warbler, and the Chiff Chaff; the Red Warbler, the March Warbler, &c. Their plumage and nests are also compared in detail.

To those who reside in the country and are fond of the study of nature, this work by Mr. Harting will be found as useful an addition to their libraries or their drawing-room tables, as it will be to ornithologists generally.

OUR BOOK SHELF

Meteorology of West Cornwall and Scilly, 1871 *and* 1874. By W. P. Dymond. (Reprinted from the Annual Reports of the Royal Cornwall Polytechnic Society, Falmouth.)

In the latter of these pamphlets Mr. Dymond gives an interesting discussion of the temperature range corrections for Falmouth, and an excellent *résumé* of the sea-temperature observations made at the same place during the three years 1872–73–74, which have been made with a just apprehension of the precautions which require to be taken, if observations of sea temperature are to have real scientific value. The omission of tables of daily maximum and minimum atmospheric pressure, which were given in the earlier issue, is a decided improvement; not so, however, is the omission of the table of the amounts of the rainfall, with the different winds, N., N.E., E., &c., which supply information of great value in defining local climates.

The five stations reported on are Scilly, Helston, Falmouth, Truro, and Bodmin, of which the most northern, as well as most elevated, is Bodmin. If we compare the mean temperatures of the stations for 1874, it is seen that at Bodmin the mean was 53°·3, and at Falmouth only 51°·8. In some of the months the discrepancy is still greater. Thus the mean temperature of Bodmin is about four degrees higher than that of Falmouth in each of the months from April to July inclusive, and about two degrees higher than at Truro, Helston, or Scilly. It is unnecessary to remark that these differences do not represent the differences of the climates of these places, but are to a very large extent only due to the incomparable modes of observation and of reduction of the observations adopted for the several stations. Thus, as regards the exposure of the thermometers, at Bodmin they are hung four-and-a-half feet above the ground, under a thatch roof, facing north; at Truro they are placed on the roof of the Royal Institution, about forty feet above the ground, in a wooden shed through which the air passes freely; at Falmouth they are eleven feet above the ground, close to a wall, and in a confined situation; at Helston we are not informed how they are placed; and at the Scilly station we are only told that they "are well placed"—a statement which the observations themselves render very doubtful.

The times of observation are hourly at Falmouth, 9 A.M. and 3 and 9 P.M. at Helston, and as respects the other three stations we have no information. In reducing the observations, "corrections for diurnal range" are used in some cases, though the observations themselves show that the range corrections adopted are plainly not even approximately correct for the place.

A system of meteorological observation which would furnish the data for an inquiry into the important question of a comparison of the local climates of Cornwall requires yet to be instituted. Such a system must secure at each of the stations included within it, uniformity in exposure of instruments, uniformity in hours of observation, and uniformity in methods of reducing the observations. Till this be done, such climatic anomalies, as we have pointed out in the case of Bodmin, will continue to be published, certainly misleading some, and probably leading others to dispute the usefulness of meteorological observations.

We have much pleasure in referring to the additional meteorological information given in the tables, which is often of considerable value, particularly that supplied for Helston by Mr. Moyle, whose tables have the merit of giving the results for the individual hours of observation, as well as deductions from these.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Vibrations of a Liquid in a Cylindrical Vessel

IN NATURE for July 15, there is a short notice of a paper read before the Physical Society by Prof. Guthrie on the period of vibration of water in cylindrical vessels. It may be of interest to point out that the results arrived at by Prof. Guthrie experimentally, and many others of a like nature, may also be obtained from theory.

In the first place the fact, that the period of a given mode of vibration of liquid in a cylindrical vessel of infinite depth and of section always similar to itself (*e.g.* always circular) is proportional to the square root of the linear dimension of the section, follows from the theory of dimensions without any calculation. For the only quantities on which the period τ could depend are (1) ρ the density of the liquid, (2) g the acceleration of gravity, and (3) the linear dimension d. Now as in the case of a common pendulum it is evident that τ cannot depend upon ρ. If the density of the liquid be doubled, the force which act upon it is also doubled, and therefore the motion is the same as before the change. Thus τ, a time, is a function of d, a length, and g. Since g is — 2 dimensions in time, $\tau \propto g^{-\frac{1}{2}}$, and therefore in order to be independent of the unit of length, it must vary as $d^{\frac{1}{2}}$ inasmuch as g is of one dimension in length. Hence $\tau \propto d^{\frac{1}{2}} g^{-\frac{1}{2}}$. This reasoning, it will be observed, only applies when the depth may be treated as infinite.

The actual calculation of τ for any given form of vessel involves, of course, high mathematics, the case of a circular section depending on Bessel's functions. But there is an interesting connection between the problem of the vibration of heavy liquid in a cylindrical vessel of any section and of finite or infinite depth, and that of the vibration of gas in the same vessel, when the motion is in two dimensions only, that is everywhere perpendicular to the generating lines of the cylinder. If λ be the wave-length of the vibration in the latter case,* which is a quantity independent of the nature of the gas, and $\kappa = 2\pi \div \lambda$, the period τ of the similar vibrations in the liquid problem is given by

$$\tau = 2\pi \div \sqrt{\frac{gk\,(\epsilon^{kl} - \epsilon^{-kl})}{\epsilon^{kl} + \epsilon^{-kl}}},$$

l being the depth. The formula shows that in accordance with Prof. Guthrie's observation τ diminishes as l increases, and that when l is sufficiently great

$$\tau = 2\pi \div \sqrt{gk}.$$

If x be the value of k, viz. $2\pi \div \lambda$, for a circular vessel of radius unity, then the values of x for the various modes of vibration are given in the following table extracted from a paper on Bessel's functions in the *Philosophical Magazine* for November 1872.

Number of Internal Spherical Nodes.	Order of Harmonic.			
	0	1	2	3
0	3·832	1·841	3·054	4·201
1	7·015	5·332	6·705	8·015
2	10·174	8.536	9·965	11·344

Thus if d be the diameter of the vessel, the period τ of the liquid vibrations is given by

$$\tau = 2\pi \sqrt{\frac{d}{2gx}};$$

so that if d be measured in inches, the number of vibrations per minute, n, is given by

$$n\sqrt{d} = \frac{30}{\pi} \sqrt{24 \times 32·19 \times x}.$$

For the symmetrical mode of vibration considered by Prof. Guthrie, $x = 3·832$, giving

$$n\sqrt{d} = 519·4$$

agreeing closely with the experimental value, viz. 517·5. Even the small difference which exists may perhaps be attributed to the insufficient depth of the vessels employed.

This mode of vibration is not, however, the gravest of which the liquid is capable. That corresponds to $x = 1·841$, giving

$$n\sqrt{d} = 360·1,$$

and belonging to a vibration in which the liquid is most raised at one end of a certain diameter, and most depressed at the other end. The latter mode of vibration is more easily excited than that experimented on by Prof. Guthrie, but inasmuch as it involves a lateral a motion of the centre of inertia, it is necessary that the vessel be held tight.

The next gravest mode gives $x = 3.054$, and corresponds to a vibration in which the liquid is simultaneously raised at *both* ends of one diameter, and depressed at both ends of the perpendicular diameter. In this case the value of n is given by

$$n\sqrt{d} = 462·7$$

Terling Place, Witham, RAYLEIGH
July 15

Insectivorous Plants

IF further confirmation be needed of Mr. Darwin's discovery of absorption by the leaves of the *Drosera rotundifolia*, it is afforded amply by the following experiments which I have just concluded:—

Having deprived a quantity of silver sand of all organic matter, I placed it in three pots, which I shall call A, B, and C. In each of these pots I placed a number of plants of the *D. rotundifolia* under the following conditions:—(1) Perfectly uninjured, but washed all over repeatedly in distilled water. (2) Similarly washed, but with all the roots pinched off close to the rosette, and with the leaves all buried, only the budding flower stalk appearing above the sand. (3) similarly washed, with the roots and the flower stalk left on, but all the leaves pinched off, the roots being buried in the sand. (4) Similarly washed, roots left on, four leaves buried in the sand, two leaves flower stalk, and roots left above the sand and the roots protected against the possibility of their absorbing anything from the sand. All the plants were carefully watched, so that no flies were caught.

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* Namely, the length of plane waves of the same period.

I fed pot A with pure distilled water, B with strong decoction of beef, and C with ·0026 per cent. solution of phosphate of ammonia.

The results are briefly these, after seventeen days' experimentation: In A all the plants are growing and looking perfectly healthy, though those with four leaves buried and the roots exposed, looked sickly for a few days. Now, however, they are putting forth new leaves; so are those with all the leaves pinched off and the roots buried.

Those with the roots pinched off and all the leaves buried are bursting into flower.

In B all the plants are greatly damaged, those with the leaves only, and those with the roots only are quite dead. Those with the roots off and the leaves buried have their leaf stalks much blackened, as described by Mr. Darwin as the result of over-feeding. The pot smells strongly of ammonia.

In C the condition is very much as in A, but the growth has been much more active, for some of the plants with the roots off and leaves buried have pushed new leaves up through the sand, and those with only four leaves buried have put out numerous new leaves, and their roots are quite dry. In one of these latter I amputated the roots five days after it had been in the pot, and it is as vigorous as the rest. About ·03 of a grain of phosphate of ammonia has been supplied to this pot during twelve days for twelve plants.

It is, therefore, perfectly certain that the sun-dew can not only absorb nutriment by its leaves, but that it can actually live by their aid alone, and that it thrives better if supplied with nitrogenous material in small quantities.

The nitrogenous matter is more readily absorbed by the leaves than by the roots, for over-feeding kills the plant sooner by the leaves alone than by the roots alone. But it is also certain that the roots absorb nitrogenous matter.

On June 17 I read a paper to the Birmingham Natural History Society, in which I announced that I had been able to separate a substance closely resembling pepsine from the secretion of the *Drosera dichotoma*. Since then I have also separated it from the fluid taken from the pitchers of various nepenthes.

The secretion from the *Dichotoma* was gathered on a feather which was washed in pure distilled water. It made the water very viscid, although probably the whole amount gathered from the only available plant was not more than six or eight minims, and an ounce of water was used. One cubic centimetre of this solution to five cubic centimetres of fresh milk separated a thick viscid mass, with a very small quantity of whey, in about twelve hours, at the ordinary temperature of the atmosphere. This mixture was kept in an open test glass three weeks, but it never became putrid.

The remainder of the solution was accidulated with dilute phosphoric acid, and then a thin mixture of chalk and water was added drop by drop till effervescence ceased. The mixture was allowed to stand for twenty-four hours and the clear fluid removed.

The precipitate was treated with very dilute hydrochloric acid, and the result treated with a saturated solution of pure cholestearine made by Beneke's method, in a mixture of absolute alcohol and absolute ether. The mass which separated was then dissolved in absolute ether, and in the resulting water was suspended a greyish flocculent matter which, on examination was found to be perfectly amorphous. It was dried at a temperature of 42°, and weighed, roughly, a third of a grain. It was partially soluble in distilled water, not at all in boiling water, greatly soluble in glycerine, and it produced the characteristic viscid change on a small quantity of fresh milk.

Fluid was taken from three nepenthe pitchers which had not opened their valves, to the amount of 2·3 cubic centimetres. It was treated in the same way as described above, and yielded a trace of the flocculent matter. Seven cubic centimetres of fluid from pitchers which had been long open and contained abundant insect *débris*, yielded the same flocculent substance. It has a specific gravity fractionally greater than water, and has reactions quite similar to the substance separated from the *D. dichotoma*, and which I propose to call droserine.

At Mr. Darwin's suggestion I have tried the action of the fluid of four virgin pitchers of the *Nepenthe phyllamphora* on cubes of albumen one millimetre in measurement. After twenty-eight hours immersion there was no indication of change by any one of the four fluids. Yet the chemical differences in all four were very marked. One only was viscid, yet it contained not a trace of the grey flocculent matter which I regard as the ferment. One only was at all acid, the other three being absolutely neutral. One contained quite a large quantity of the ferment, whilst the fourth had no reaction in silver lactate, so that I imagine it was only pure water. On the contrary, fluid taken from pitchers into which flies have previously found their way is always very acid, has a large quantity of the ferment, and acts in a few hours on cubes of albumen, making them first yellow, then transparent, and finally completely dissolving them.

The quantities obtained were too small to submit to analysis, and I am not sufficiently an adept in chemical manipulation to give a better account of this interesting substance.

When studying the nepenthes, I was puzzled to see the use of the channel which exists on the back of the pitchers, and which is formed by two ridges furnished with spikes in most of the nepenthes, but not in all, which run up to the margin of the lip of the pitcher.

I found that one plant under observation was infested by a small red ant-like insect, numbers of which had found their way into one particular pitcher. I observed two or three on the leaf of this pitcher, and I carefully observed their movements. They occasionally approached the edge of the leaf, but always turned back when they encountered the spikes which run down the margin, and which are the same as are seen on the ridges. In all the mature pitchers the stalk hangs in contact with the pitcher just between those two ridges, about half way between the attachment of the stalk and the lip of the pitcher.

At this point of contact the insects marched on to the pitcher, and then, of course, found themselves on the pathway between the ridges. Here they again always turned back when they encountered the spikes, so that they soon found their way to the lip.

Here they paused, and seemed to enjoy some secretion which seems to be poured out on the glazed surface of the lip. Then they travelled onwards, and met the fate of their companions. I found about thirty of these insects in this pitcher, and as they were in various stages of digestion, I presume they were entrapped at different times. I could see no reason why they all went to this pitcher, though no doubt there was one. The secretion in which they were being digested was very viscid and very acid. In the unopened pitcher the secretion is only faintly acid and not at all viscid. The secretion is increased, therefore, as Mr. Darwin has shown to be the case in *Drosera*, in quality after food has been taken in.

The footpath extending from the petiole to the lip of the pitcher, armed on each side with a *chevaux-de-frise*, to prevent the prey wandering off, is a contrivance which is manifestly for the advantage of the plant; so also, is the umbrella which is extended over the orifices of the pitchers in many of the nepenthes. Its obvious use is to prevent dilution of their gastric juice. In some the lid does not cover the orifice; probably there is something special in their habits.

The glands which line the pitchers differ considerably from the *Dionœa*, and they are placed in curious little pockets of epithelial cells, the meaning of which is not evident.

LAWSON TAIT

Curious Phenomenon in the Eclipse of 1927

ON the morning of June 29, 1927, there will be the next solar eclipse in England in which anything in the shape of totality can be seen. In an examination of eclipses I made two or three years ago, I considered this one would be total for a brief period in the north of England, as mentioned in NATURE, vol. xii. p. 213. But the curious point worthy of notice is the following:—As the moon's disc only just overlaps that of the sun, we may expect to see the red flames visible, not as prominences, but as a line of red light encircling the sun for a few moments. The probable appearance of such a phenomenon in a slightly total eclipse of the sun was pointed out by Prof. Grant in a paper in the December Notices of the R.A.S., 1871 (q.v.) The eclipse of June 29, 1927, seems to afford such an opportunity as the Professor wished to find out. Although this eclipse, therefore, is but an apology for a total one, it may acquire an interest of its own for posterity. See my little work, "Eclipses Past and Future" (Parkers) on this subject.

SAMUEL J. JOHNSON
Upton Helions Rectory, Crediton, Devon

Spectroscopic *prévision* of Rain with a High Barometer

MY letter of last Monday (in last week's NATURE, p. 231) having been sent off when we (in Edinburgh) were still in the midst of heavy rain, N.E. wind, high barometric pressure, and an abnormal sky-spectrum, you may be interested in hearing how matters quieted down until this Monday, when we have a delightful drying west wind, high floating clouds, and a normal sky-spectrum showing fine lines only.

On Tuesday the 20th then, there was a sensible alleviation of Monday's abnormal spectrum bands, though they were still there; and the weather, though dark, began to clear.

On the 21st and 22nd, the abnormal bands had almost disappeared, leaving the lines proper of the spectrum easily visible, and the weather was fine.

Friday, the 23rd, however, was wet by day and very wet at night; yet the sky-spectrum was good and nearly normal. Note, however, from the Meteorological Journal below,* that this rain came with a west wind, a low barometer, and a considerable fall of temperature. And the wind has been westerly ever since, and with a normal sky-spectrum.

Hence the intensification of the band on the less refrangible side of D would seem to be thus far identifiable both in London and Edinburgh with warm rain in an easterly wind and under a high barometer.

While, that the said band really was intensified to a very noteworthy degree, and quite abnormally both with respect to the broader band which appears on the *more* refrangible side of D (or over W.L.L. 5830—5680), and to other telluric manifestations, at sunset—is demonstrated now most satisfactorily by my having just heard from my friend, Prof. P. G. Tait, M.A., whom I had not seen for six weeks before, that he has been independently observing in Edinburgh the very same phenomenon, and almost at the same times, and on the same days. He was much struck too at obtaining the chief abnormal band on the most marked days from *all* parts of the sky and at all hours, and had considered what it might mean.

He has further pointed out to me since then, that Angstrom's map shows fine telluric lines in the place of the grand smoky band we observed with small spectroscopic power in W.L.L. 6000–5880; but makes them much less, instead of very much more, dark than the well-known 5830–5680 evening band; so that the question now is, what is it that *intensifies* the former and not the latter under the meteorological conditions noted?

15 Royal Terrace, Edinburgh, July 26

PIAZZI SMYTH
Astronomer Royal for Scotland

Sea-power

I OBSERVE that a correspondent at Giessen asks (NATURE, vol. xii. p. 212) for information as to Sea-power. If he will consult Sir Robert Kane's "Industrial Resources of Ireland" he will find what he wants, with a view to what have been termed "tidal mills."

A. C.

Edinburgh, July 26

OUR BOTANICAL COLUMN

THE ADELAIDE BOTANIC GARDEN.—From Dr. Schomburgk's Report on the progress and condition of the Adelaide Botanic Garden and Government Plantations during the year 1874, we gather some facts relating not only to the capabilities of the Garden in an educational point of view, but also with regard to the acclimatisation of new plants, many of which are valuable for their economical products, and others as horticultural novelties. In what is called the class ground 130 natural orders are represented and 750 genera. The plan adopted seems to be similar to that adopted in most botanic gardens, namely, by dividing the orders by strips of turf; the aquatic plants, such as the Nymphæaceæ, Vallisneriæ, Butomaceæ, Alismaceæ, &c., are arranged in a basin in the centre. Dr. Schomburgk points out what is apparent to all botanical students, that it is almost an impossibility to lay out a systematic ground perfectly, as the representatives of some orders are composed partly of natives of cool and partly of tropical countries, while other orders are solely tropical plants: the same difficulty also occurs in the lower orders of plants, such as Cryptogams. As Dr. Schomburgk says, it is to be hoped that this comparatively new feature in the plan of the Adelaide Garden will be useful to the students at the University, the foundation of which we are told is now a fact, and so promote the study of botany in South Australia. In the experimental garden great success seems to have been attained in growing the Tussack grass (*Dactylis cæspitosa*). As is well known, this plant forms a most nutritious fodder; and it is thought that if it succeeds, it will prove a most valuable acquisition to the scanty stock of good Australian fodder plants. The seed was received in Adelaide in September last, and upon being at once sown soon made its appearance above ground: the quickness of growth is said to be surprising; many of the plants in 4-inch pots showed, at the time of writing the report at the latter end of February, seventy to eighty shoots. About a dozen plants were put out in 6-inch pots, and these in the same period had as many as 123 shoots, the blades of which were remarkably sweet and soft and of a good flavour. Dr. Schomburgk says that he is convinced, though the native countries of the Tussack are much colder than Australia, it will do well in the hills; he has about 1,000 plants in pots, which are naturally sheltered part of the day from the sun, and are also watered; many of the plants are during the day more or less exposed to the sun, but he has observed no difference in their growth. It is remarkable that, notwithstanding all the pains that have been taken, both at home and in Australia, to introduce many of these useful grasses, little or no interest seems to be taken by the colonists themselves in the matter for whose benefit they are specially undertaken.

The Liberian Coffee, about which so much has been said and so much more is expected, has likewise found its way to Adelaide, four healthy plants having been received from Mr. Bull, of Chelsea. Among other economic plants recommended by Dr. Schomburgk for trial in South Australia may be mentioned the Liquorice (*Glycyrrhiza glabra*).

SUMBUL ROOT, the tincture of which is now so frequently prescribed as a stimulating tonic, had, previous to the discovery of the plant in 1869, a peculiar mystery attached to it regarding its origin, and this mystery was all the more intense from the fact that in commerce dealers distinguished Sumbul by two or three different qualities, each of which was said to be derived from different countries. Thus, the best kind was distinctly known as Russian Sumbul, and the second quality as Indian Sumbul, a variety or form of which was also known as China Sumbul, being shipped to England *viâ* China, while the Indian kind is brought from Bombay. Of the plant furnishing this Indian or Chinese product we know nothing. The root is described by Pereira in his "Elements of Materia Medica" as being of a closer texture, firmer, denser, and of a more reddish tint than the Russian sort, and of a less powerful odour. The authors of the "Pharmacographia," however, consider it "to be a root different from Sumbul," that is, the true or Russian Sumbul. The mystery regarding the botanical origin of this latter has within the last few years been cleared up by the discovery, in 1869, of living plants in the mountains near Pianjakent, a Russian town eastward of Samarcand. The Botanic Garden at Moscow was fortunate enough to receive a living plant which flowered in 1871, and was thereupon named by Kauffmann *Euryangium Sumbul*. A plant was introduced to the Royal Gardens, Kew, some two or three years since, and planted in the open ground, where it has flourished through the summer, throwing up its strong, bright green *Ferula*-like leaves, and dying down to the earth in winter, during which period it has received artificial protection. Up to the present season the plant has never flowered, but recently it has thrown up a strong and healthy umbel, some seven or eight feet high. It is only in quite recent times (1867) that the Sumbul has been admitted into the British Pharmacopœia. In the first edition, which was issued in 1864, it was not included. It has now become largely used, and its application is still increasing, being frequently administered in cases where quinine is too powerful. The root is of a soft spongy nature, with numerous interlacing fibres; it has a bitter aromatic taste, and a strong musk-like smell which it is capable of retaining for a great length of time, the specimens contained in the Kew Museum, where they have been for the last twenty-four years, retaining still the odour in a marked degree.

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* *Meteorological Journal at* 1 P.M. *Royal Observatory, Edinburgh.*

Date.	Barometer reduced to sea-level.	Attached Thermometer.	Exterior Thermometer, in shade.	Direction of wind.
1875.	inches.	° F.	° F.	
July 20	30·08	60·0	61·5	N.E.
,, 21	30·01	62·2	64·7	N.E.
,, 22	29·74	63·5	68·1	N.E.
,, 23	29·58	61·8	58·9	W.
,, 24	29·49	57·4	57·6	W.
,, 25	—	—	—	—
,, 26	30·24	58·0	60·3	W.

THE PROGRESS OF THE TELEGRAPH *

IX.

In all submarine cables the copper conductor is composed of seven small wires stranded together, an arrangement which gives much greater flexibility and strength than if a solid wire were employed. The general arrangement of the signal apparatus in connection with the cable is shown at Fig. 38. A, the battery, consists of a series of cells of Daniell's arrangement; B, the contact keys for passing the positive and negative currents into the cable; C, "switch," placing the cable in connection either with the earth, instrument, or battery as required; D, a form of Sir William Thomson's reflecting galvanometer placed in connection with the cable by switch C; E, the permanent magnet arrangement for steadying and adjusting the coil-mirror (shown in section and detail, Fig. 39); I, resistance coils interposed into the circuit between the instrument and the earth; J, a switch for connecting the line to earth; F, a darkened recess to receive the scale upon which the spot of light reflected from the lamp situated behind the partition, the ray from which, passing through a slit in the direction R is reflected back from the galvanometer mirror in the direction R′; the spot of light moves to the right or left of the zero on the scale, according as a positive or negative current is passed through the circuit; the several signals being indicated by the successive oscillations of the luminous image, signals which correspond to the conventional alphabet of the Morse system. The Morse alphabet is given at Fig. 40.

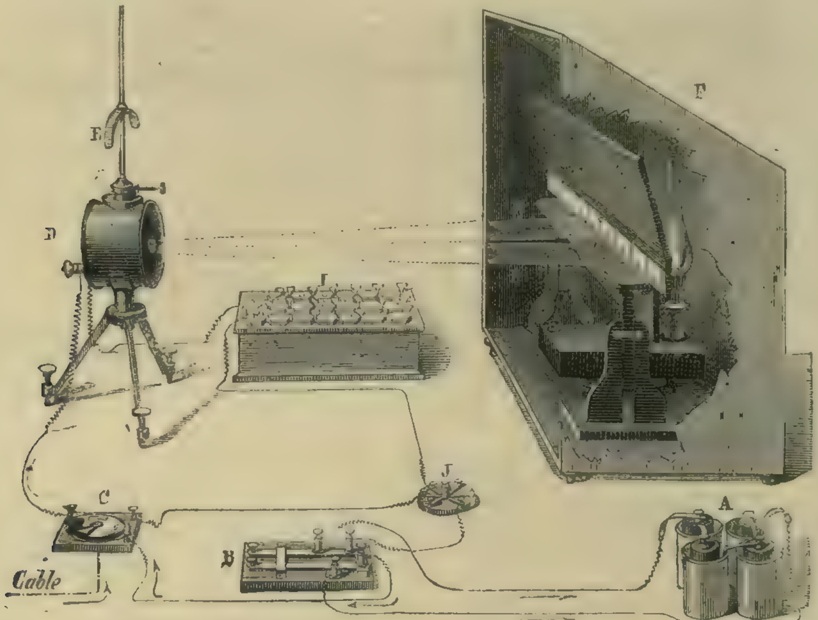

FIG. 38.—Genera arrangement of apparatus for working a submarine circuit.

A steam-engine without the motive power, steam, is nothing but an arrangement of iron levers, cranks, and throttle valves, useless so far as actual work is concerned. In like manner a telegraph instrument without the electric current to actuate its parts and give vitality to the circuit is valueless—a piece of apparatus to be inspected on a museum shelf. A few remarks upon "Batteries" are therefore necessary before an examination is made into the chief laws which regulate the passage of electric currents through metallic conductors.

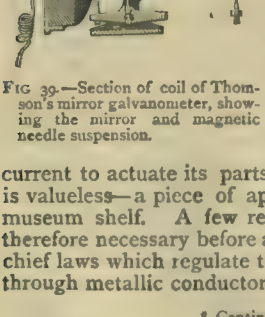

FIG 39.—Section of coil of Thomson's mirror galvanometer, showing the mirror and magnetic needle suspension.

In the production of a galvanic, or voltaic current, two conditions are essential, either the presence of two metals and a liquid, or two liquids and a metal. This will be explained by reference to everyday phenomena.

a	· —	o	— — —
ä	· — · —	ö	— — — ·
b	— · · ·	p	· — — ·
c	— · — ·	q	— — · —
d	— · ·	r	· — ·
e	·	s	· · ·
é	· · — · ·	t	—
f	· · — ·	u	· · —
g	— — ·	ü	· · — —
h	· · · ·	v	· · · —
i	· ·	w	· — —
j	· — — —	x	— · · —
k	— · —	y	— · — —
l	· — · ·	z	— — · ·
m	— —	ch	— — — —
n	— ·		

FIG. 40.—The Morse Alphabetical Code.

A familiar example of the development of an electric current by two metals and a liquid is continually presented to our notice in the wasting of the iron bars of a railing close to their junction with the stone coping. Here we have the two metals, the iron composing the

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* Continued from p. 151.

railing, and the lead by which the iron is fastened into the stone, and rain or atmospheric moisture, as the liquid or exciting medium. The wasting away of the iron just above the coping stone is the result of the galvanic action set up between the two metals (iron and lead) and the liquid (the moisture of the atmosphere). To preserve an iron railing therefore it becomes necessary to dispense with the presence of lead; nothing can be better than the adoption of an iron coping in place of stone. As knowledge spreads, so practical results follow, and many modern examples of iron railings will be found to fulfil the conditions above indicated as necessary to ensure a "long life."

All connoisseurs of malt and hop beverages agree that ale drinks much sharper and is more tasty to the palate out of a pewter tankard than out of a glass. At a refreshment bar the demand is more often for "half a pint of bitter" (served in a metal vessel) than for a "glass of bitter;" and common belief in this instance is correct. Here we have a galvanic current set up by two liquids and one metal; the effect of the electric current so generated being to sharpen and improve the taste of the beverage to the palate by reason of electric action. In this example there are the two liquids—the beverage, and the saliva of the mouth—and one metal—that of the tankard—the resultant effect on the palate of the consumer being an increased life or vigour in the taste of the beverage. Thus, even in the trivialities of everyday life, electricity has a part to play. The generation of the voltaic current for telegraphic purposes is based upon one or other of these principles; and it is essential in telegraphy that the power of the current derived from the battery should be adjusted to the circuit.

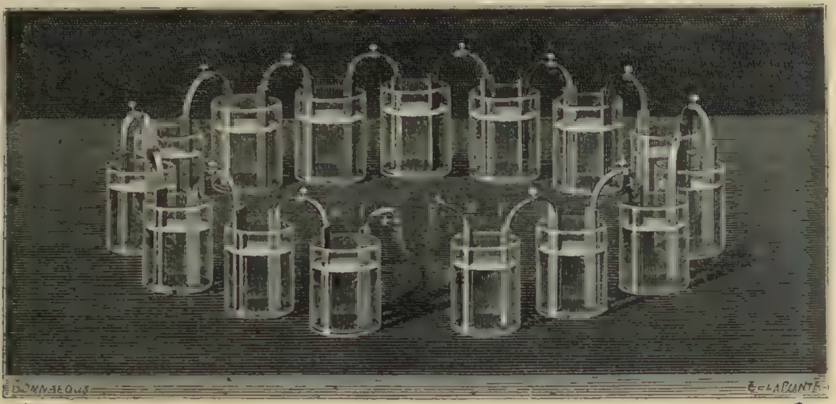

Fig. 41.—Voltaic Battery connected in series, in illustration of the *internal resistance* of the battery.

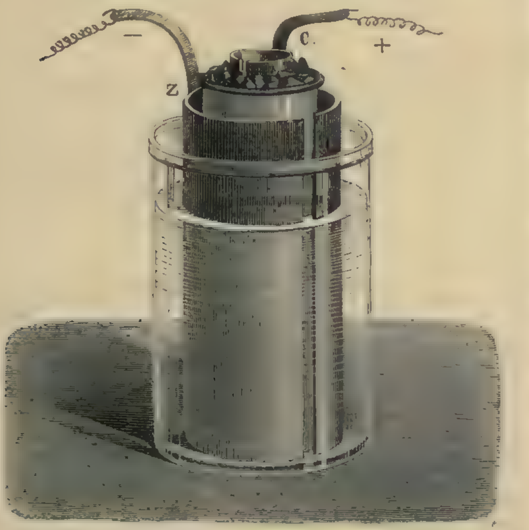

Fig. 42.—The Daniell Battery.

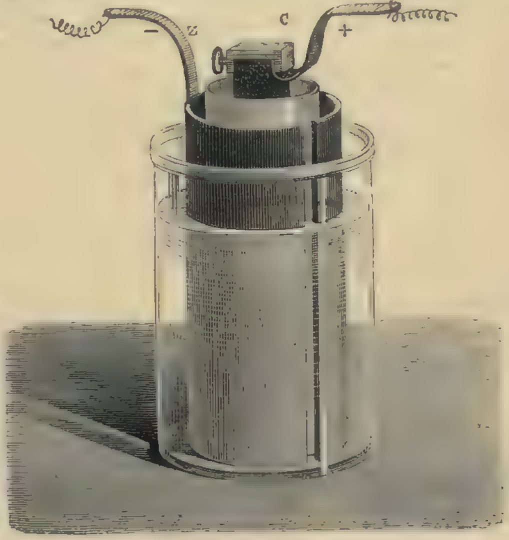

Fig. 43.—The Bunsen Battery.

The strength of the current depends on the *electromotive force* of the battery and upon the *resistance* of the circuit. The precise meaning to be attached to these terms was first pointed out by Ohm in 1827, who showed that the strength of the current is directly proportional to the former and inversely proportional to the latter. The statement of this relation is commonly spoken of as "Ohm's Law." The total resistance of a telegraphic circuit is made up partly of the resistance of the *battery*, and its necessary connections, and partly of the resistance of the metallic conductor constituting the *line*. Consequently the law established by Ohm may be expressed as follows:—

The available effective force of any current = the electromotive force of the Battery—(the resistance of the Battery + the resistance of the line wire).

It has been found that in any given case the electromotive force and resistance depend upon conditions that may be thus stated:—

First, "*The electromotive force* of a voltaic circuit varies with the number of the elements, and the nature of the metals and liquids which constitute each element, but is in no degree dependent on the dimensions of any of their parts." Second, "*The resistance* of each element is directly proportional to the distances of the plates from each other in the liquid, and to the specific resistance of the liquid; and is also inversely proportional to the surface of the plates in contact with the liquids." Third, "*The resistance of the connecting wire of the circuit* is directly proportional to its length and to its specific resistance, and inversely proportional to its section." Some of the more important forms of battery in use will now be described.

Daniell's Battery, Fig. 42, consists of an earthenware or glass vessel, within which a smaller jar of some porous material is placed; the space between the inner and outer jars is filled with a dilute solution of sulphuric acid and water, and within the porous jar a saturated solution of sulphate of copper; a cylinder of zinc is immersed in the acid solution, and a cylinder of copper in the sulphate solution, crystals of sulphate of copper being introduced to maintain the strength of the copper medium. The current from this battery is remarkably constant, a matter of the greatest importance in the working of a telegraphic circuit, as with a variation in the working strength of the current, continued adjustment of the transmitting and recording apparatus is rendered necessary. Bunsen's battery (Fig. 43) in many respects resembles the Daniell arrangement; carbon is used within the porous cell in place of the copper cylinder, and nitric acid replaces the saturated solution of sulphate of copper. The current produced is stronger, but less constant than that from the Daniell's cell.

Many other arrangements for the generation of a voltaic current for telegraphic purposes are in use, such as the "Marié Davy" (Fig. 44), the "Leclanché," and "Callaud" batteries; more or less, each has its special merits and demerits: practically, the "Daniell" remains unsurpassed. The essential condition of every practical form of battery is that it shall produce a constant current be free from local action, and possess mechanical facility of renovation, with simplicity and economy of construction.

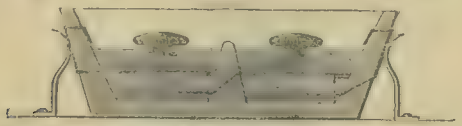

FIG. 44.—The Marié Davy sulphate of mercury Battery.

The measurement of the value of every telegraphic line as regards electrical resistance, as compared with some ascertained standard of resistance, is a matter of vast importance. By this means the electrical insulation of a submarine cable or a land wire is definitely ascertained, and the existence of a fault, together with its locality, defined. Without some established *unit* of resistance by which to compare the working circuit with its electrical equivalent, no test of insulation can be maintained or restoration of a circuit carried out. By general acceptance a standard of measurement has been adopted, a unit of resistance known as the B.A. (British Association) unit. It is unnecessary to enter into detail as to the mechanical problems which determine this unit of resistance; it is sufficient to state that the electrical resistance or value of every circuit, land wire and submarine cable, is now by universal acceptance recorded in B.A. units. For instance, a guttapercha submarine cable core may be stated to be so many hundred millions B.A. units of insulation test; while, again, an indiarubber core may be stated to be so many thousand millions of B.A. units of resistance; a correct comparison is thus at once determined.

(*To be continued.*)

OUR ASTRONOMICAL COLUMN

THE TRANSIT OF VENUS, 1882 DECEMBER 6.—The Greenwich time of first *internal* contact in this transit at any point in these islands, according to Leverrier's Tables of Sun and Planet, may be accurately found by the following equation, in which l is the geocentric latitude of the place, ρ the corresponding radius of the earth, and L the longitude, reckoned positive, if east of Greenwich, and negative, if west:—

$$\text{G.M.T. first Int. Cont.} = \text{Dec. 6d. 2h. 16m. 16s.}$$
$$+ [2{\cdot}5855]\,\rho \sin l - [2{\cdot}4774]\,\rho \cos l \cos (\text{L} - 85^\circ\,58'{\cdot}6)$$

The quantities within square brackets are logarithms; the correction of course results in seconds. Direct computations for Greenwich, Edinburgh, and Dublin, furnish the following particulars of the first internal contact at these places:—

	Local Time.	Angle from N. point.	Angle from Vertex.	Sun's Altitude.
	d. h. m. s.	° ′	° ′	°
Greenwich ...	Dec. 6 2 21 2 ...	150 40 ...	128 2 ...	9·2
Edinburgh ...	„ 2 8 46 ...	150 42 ...	132 8 ...	6·5
Dublin ...	„ 1 56 8 ...	150 41 ...	132 24 ...	9·6

At Greenwich the sun sets just one hour and a half after Venus has wholly entered upon the sun's disc.

THE SUN'S PARALLAX.—M. Liais, Director of the Imperial Observatory of Rio de Janeiro, has intimated his intention to make a serious attempt to determine this important element from the very favourable opposition of the planet Mars, which will occur early in September 1877, being encouraged thereto by the success which attended his observations about the opposition of 1860, when his instrumental appliances were very inferior to what they are likely to be in 1877. The planet arrives at perihelion on the 21st of August in that year, and in opposition at midnight on the 5th of September; it is in perigee on September 2nd at a distance of only 0·3767, which is not far from the minimum, though slightly greater than in the last three repetitions of the 79-year period, as will appear from the following comparison:—

Opposition.	Mars—Mean Anomaly.
1640·64	− 0° 12′
1719·65	+ 2 31
1798·66	+ 5 15
1877·68	+ 7 58

The horizontal parallax of Mars will attain a value which, as M. Liais remarks, will be sensibly equal to that of Venus, diminished by that of the sun. With firm instruments and experienced observers, it is very probable that the amount of solar parallax may be determined by differential observations of Mars at the opposition of 1877, with a precision which may be comparable with that resulting from observations of a single transit of Venus.

A THIRD COMET IN 1813 (?).—Bode, after mentioning in his Miscellaneous Notices (*Berl. Jahrb.* 1818) that Canon Stark of Augsburg had observed the first comet of 1813 on the 19th of February, states that Stark had also discovered on the same evening with a 3½ feet Dollond telescope, a very small and exceedingly faint comet without tail above the variable star Mira in Cetus, the position of which, by comparison with the variable, he found to be at 7h. 28m. 37s., in R.A. 31° 17′ 23″, and Decl. 1° 52′ 9″ S. He saw the comet a second time on the 20th, and again comparing it with Mira, and another adjacent star, its place at 7h. 32m. 13s. was in R.A. 33° 47′ 3″, and Decl. 5° 49′ 7″ S. Cloudy skies are said to have prevented further observation. Bode remarks, with respect to this comet, that it is strange that no other astronomer had perceived it, "doch versichert Herr Stark," he adds, "noch in seinem letzten Schreiben an mich, aufs Heiligste, die Richtigkeit dieser Wahrnehmung." However suspicious this circumstance may have appeared, we know that several of the comets of short period have been revolving in such orbits for one or two centuries, visiting these parts of space without doubt under favourable circumstances for observation on more than one occasion, yet entirely escaping detection, so that the mere fact of a single observer only having seen a comet, is hardly a sufficient argument against its existence. The late Prof. d'Arrest even thought it worth while to submit the reputed observations of the D'Angos-Comet of 1784 to further calculation, notwithstanding Encke's well-known investigation in the "Correspondance Astronomique" of the Baron de Zach, and we may have something to say on this subject in a future column. Not having seen any reference to "Stark's comet" in English astronomical works, we have given the particulars recorded of it here.

THE GREAT COMET OF 1843.—There was some doubt at the time, from the difficulty attending the determination of the orbit of this extraordinary body upon the European observations, whether it had transited the sun's disc on the day of perihelion or not. The definitive orbit calculated by a most complete investigation by the late Prof. Hubbard, of Washington, shows that a transit did actually take place on the evening of February 27, Greenwich time, and might have been observed in Australia. In next week's "Astronomical Column" we shall give the particulars of this interesting phenomenon, and reproduce Hubbard's elements with some inferences drawn from them.

D'ARREST'S COMET IN 1877.—The mean motion of this comet at the last appearance in 1870, determined by M. Leveau from an elaborate calculation of the perturbations in the two preceding revolutions, would bring this comet into perihelion again on April 17, 1877. The effect of planetary attraction in the present revolution being comparatively small, if we take this date for perihelion passage, the computed path is not likely to differ materially from the true one. It is as follows:—

Obs. Greenwich.		R.A.		N.P.D.		Distance. from Earth.
		h. m.		°		
1877 March 8	...	20 51	....	100·6	...	2·03
„ 28	...	22 6	...	97·2	...	1·94
April 17	...	23 16	...	93·2	...	1·89
May 7	...	0 25	...	89·2	...	1·89
„ 27	...	1 30	...	85·7	...	1·90

It would appear from this track that the only chances of observation will be with the aid of powerful telescopes in the southern hemisphere. At the last return the comet was excessively faint, and was only detected at a few of the European observatories.

THE INTERNATIONAL GEOGRAPHICAL EXHIBITION

THE idea of holding an International Geographical Exhibition at Paris, the opening of which we announced last week, in connection with the Geographical Congress which opens in a day or two, was a happy one, and has so far been fruitful in results. The catalogue of articles exhibited covers about 450 octavo pages, and the daily number of visitors reaches thousands; last Sunday it was 12,000, including the Sultan of Zanzibar, and other visitors of all ranks and classes of society. No better method could have been adopted of showing the advances made in geography in recent years; how from being a mere record of "hairbreadth 'scapes by flood and field," it has become a complicated science, or rather meeting-ground of all the sciences; for, as the equipment of and instructions to the English Arctic Expedition show, it requires the aid of all the sciences to do its work well, and in return carries contributions back to them all. We have no doubt that the great majority of the visitors to the Exhibition will be astonished that geography has so many and so varied apparatus and results to show, and we hope that the Exhibition and Congress will be the means of awakening in France, as well as in other countries, an increased interest in geography, lead to its being raised to a higher platform in education, and to its being taught in a more comprehensive and more scientific way than hitherto. No doubt this will be but the first of a series of such exhibitions and congresses, though probably not annual, and we hope that the next one will be held in London. We think they are well calculated to give a strong stimulus to the scientific study of geography.

The arrangements of the Paris Exhibition make it accessible to all classes, the price of admission in some cases being as low as a penny. The articles are arranged mainly according to countries, Britain occupying but a comparatively narrow space in the catalogue. While Russia has 42 pages, Sweden, Norway, and Denmark about 40, Holland 30, Austria and Hungary 44, Great Britain and her Colonies cover only 9 pages. Even Germany has only 12 pages allotted to her. These apparent anomalies no doubt arise from some imperfections in the preliminary arrangements, and are probably to be looked for in first attempts of this kind; no doubt the organisers of the next Geographical Exhibition will profit by the defects of the present, and have one complete all round.

As our readers are aware, the objects exhibited are classified into seven groups; an indication of what is included in each group will convey some idea of the nature of the objects exhibited, as well as of the comprehensive nature of modern geography.

Group I., Mathematical Geography, Geodesy, and Topography, includes of course instruments of practical geometry, surveying, topography, geodesy and astronomy; tables of projection and calculation, maps according to the various systems of projection, sidereal maps, maps of triangulation, maps showing the curves of magnetic declination, &c. In the second group, that of Hydrography and Maritime Geography, is included a great variety of instruments besides those used on board all sea-going ships; there are dredging and sounding apparatus with specimens of what is brought up from the sea-bottom, sounding thermometers and charts, and publications of various kinds. The third group is an interesting one; it includes Physical Geography, General Meteorology, General Geology, Botanical and Geological Geography, and General Anthropology. These are illustrated by instruments used in the observation of the principal meteorological phenomena, by maps, atlases and globes representing the essential facts belonging to the domain of Physical Geography, Meteorology, and the other sciences referred to, as well as publications bearing upon them. In group IV., that of Historical Geography, History of Geography, Ethnography, and Philology, are included, works and MSS., ancient and modern, bearing on these subjects, ancient globes and maps, antiquated instruments, ethnographic collections, and dictionaries of geography.

As might be expected, the fifth group, Economic, Commercial, and Statistical Geography is a large and varied one; it includes works and maps bearing on population, agriculture, industry, commerce, ways of communication, ports, colonisation, emigration, &c., plans and models of bridges, tunnels, railways, routes, telegraph lines; new apparatus for piercing rocks, manufactures or mineral objects peculiar to any country, collections of all kinds of commercial products, machinery used in manufactures of such products, produce and apparatus of deep-sea fishing, &c. Group VI., Education and the Diffusion of Geography, includes of course works, maps, charts, globes, models and instruments of various kinds, and deserves the attention of all engaged in education. Group VII. comprehends Explorations, Scientific, Commercial, and Picturesque Voyages, and, as might be expected, includes a great variety of objects. There are astronomical, topographical, meteorological, and photographic instruments of various kinds; collections of every kind bearing on voyages of exploration, including cooking apparatus and drugs; native implements and weapons; tents and boats of various kinds, special instruments and apparatus for polar expeditions, &c., not to mention narratives and publications of every kind relating to voyages.

How varied the programme of this exhibition is will be seen from the above, as well as the fact that the geography of the present day is a very complicated and all-embracing province of knowledge indeed.

It is impossible here to analyse in detail the exhibits of each country; we can only at present refer to some of the objects which, as we learn from a correspondent, have attracted considerable attention.

The fine set of instruments for travellers exhibited by our Royal Geographical Society, and invented by Capt. Georges, R.N., seems to have excited considerable attention; it includes a double pocket sextant, an artificial horizon, and a barometer; the latter especially, on account of its ingenious construction, making it useful in mountaineering, is said to have attracted the attention of the New French Alpine Club.

From Norway comes a very simple declimeter having a crank working on a small notched wheel which multiplies by ten the number of degrees on the limb on which the readings are taken; a close approximation can thus be obtained by a very simple contrivance.

A Russian marine officer has sent a compass magnificently fitted up, and a lead for taking soundings, and samples of the bottom in lakes and shallow seas. It was used with success on Ladoga, the Caspian, and the Baltic. The apparatus is very simple, cheap, and not ponderous.

Mohn's map of churches struck by lightning in Norway is exhibited in order to illustrate the special danger of lightning to churches. It shows that two churches in every three years are struck and one of the two is utterly destroyed, and that in a climate where thunderstorms are relatively infrequent.

Sweden exhibits two wonderful pieces of apparatus. The first is a meteorograph for printing in numbers the degrees of dry and wet bulb thermometer, barometer, and the force of the wind. The types are placed on wheels which are moved every quarter of an hour by electricity. The barometer is a syphon one, and the thermometers open by the top a needle which descends every quarter of an hour into the mercury and gives the degree. The apparatus works regularly at the University of Upsal and at the Vienna Observatory, where the readings have been found quite correct. The printed sheets obtained at Upsal are posted on the wall of the Geographical Exhibition.

A Swedish engineer has invented a machine to show where to find beds of iron ore, and to determine also the depth to which it is necessary to descend. The miracle is performed by tracing on a map isodynamic magnetic curves, with a compass exposed to the perturbating influence of a magnetic needle placed at a distance. Two systems of isodynamic curves are to be traced, and the distance between both centres is proved to indicate the depth. Experiments and explorations with this extraordinary instrument have proved successful.

The Belgian universal meteorograph, as used in Ghent, is said to be the great success of the Exhibition. It is expected to create a revolution in weather-warnings and in meteorology generally, and will leave the famous Greenwich registering apparatus far behind. A reading is taken every quarter of an hour and engraved on copper ready for going through the press. The inventor is M. Van Rysselberghe, Professor to the Navigation School of Ostend.

The members of the several juries visited the galleries of the Exhibition on Monday last for the first time. Many members of the Academy of Science—MM. Leverrier, Faye, Quatrefages, and others—were present, as well as the foreign commissioners. We hope to give further details next week.

THE REGULATION OF RIVERS

THE recent disastrous floods in France and England call attention to the question whether it is practicable so to regulate the flow of the water in rivers as to prevent, or at least greatly diminish, such misfortunes for the future. Facts and numerical data exist which show that such regulation is practicable with much less difficulty and cost than would be thought by any one who had not made the necessary calculations.

It is perhaps scarcely necessary to say that the method of keeping the floods off the lands by means of embankments, which is the only possible resource when we have to contend against the sea or tidal rivers, is totally inapplicable to the case of the inundations of mountain streams like the Garonne. There need not be any difficulty as to the strength of the embankments, but it would be impracticable to make them high enough to contain between them such torrents as that of the Garonne when in flood. The only way in which mountain torrents can be regulated is by constructing reservoirs to retain the flood-water: and the more this plan is looked at, the more feasible it will appear.

We shall first refer to a paper by Charles Ellett, jun., C.E., on "the Physical Geography of the Mississippi Valley, with suggestions for the improvement of the navigation of the Ohio and other Rivers," forming part of the "Smithsonian Contributions to knowledge" for 1851, published by the Smithsonian Institution, Washington.

This paper contains the tabulated results of an elaborate series of observations made by the author in the spring and summer of 1849 on the flow of the Ohio, at Wheeling, between Pittsburg and Cincinnati. The flow varied from 10,158,000 cubic feet per hour, with a depth of 2.20 feet on the bar at Wheeling, to 736,000,000 cubic feet, with a depth of 31·25 feet on the bar.

"The average volume of water annually flowing down the Ohio is 835,000,000,000 (eight hundred and thirty-five thousand million) cubic feet. This volume would fill a lake 100 feet deep and 17⅓ miles square. To have regulated the supply of the river in 1848, so as to have kept the depth on the bar at Wheeling uniform throughout the year, would have required reservoirs capable of holding 240,000,000,000 cubic feet, which is equivalent to a single lake 100 feet deep, and 9⅛ miles square. There is no difficulty, on any of the principal tributaries of the upper Ohio, in obtaining reservoirs capable of holding from twelve to twenty thousand millions of cubic feet. It can scarcely be doubted that twelve or fifteen sites for dams may be selected capacious enough to hold all the excess of water, and equalise the annual discharge so nearly that the depth may be kept within a very few feet of an invariable height."

To control the floods of the river, however, much less than this would be needed. Mr. Ellett takes the case of the flood of March 1841, as being that in which the greatest quantity of water passed down of all the floods concerning which he has information. He takes 25 feet of depth on the bar as the high-water mark, above which the river is in flood; he estimates that during nine days of flood the river passed down 159,000,000,000 cubic feet of water, while during the same time, had it been steady at the high-water mark, the discharge would have been only 115,000,000,000. If consequently the excess of 44,000,000,000 had been kept back in reservoirs, the flood would have been prevented.

The volume it is here proposed to deal with—44,000,000,000 cubic feet—is "just equal to the quantity the river would discharge in fifty days when there is a depth of five feet in the channel."

The valley of the upper Alleghany, one of the tributaries of the Ohio, is about a third of a mile in width. A dam from 55 to 60 feet in height, thrown across the trough of this valley, so as to submerge not only the main valley but its branches, would, according to Mr. Ellett, "probably form a lake covering from 16 to 18 square miles, with an average depth of nearly 30 feet, and containing more than 12,000,000,000 cubic feet of water." "It follows then that we should need but four dams, such as we have described, to secure the valley of the Upper Ohio against all destructive floods.

This however assumes that at the beginning of a flood the reservoirs will be empty—a condition on which it would not be safe to rely. It also seems that the shape of the valleys of the tributaries of the Ohio is everything that could be wished by an engineer who desired to convert them by means of dams into artificial lakes. They are trough-shaped, moderately wide, long, and not too steep. This last is a great advantage, because the steeper the valley the shorter is the lake that will be formed by a dam across it. It is likely that the Garonne and its tributaries are less favourably circumstanced, but nevertheless in a country of such varied contour as the south-west of France, there must be many eligible sites for reservoirs. In another way also the Garonne will certainly be found a less manageable river than the Ohio, namely that the volume of its floods bears a much higher ratio to its ordinary flow.

After the disastrous floods of the Loire in 1855, the late Emperor wrote a letter to his Minister of Public Works recommending the control of the floods by means of a number of small reservoirs to be formed by building dams across the mountain valleys. This however was lost sight of, and we see the result in the ruins of Toulouse.

A most useful work of this kind has been in operation for many years in Ireland. The following particulars are taken from a paper "on the Industrial Uses of the Upper Bann River," by John Smyth, jun., C.E., read at the Belfast Meeting of the British Association last year, and ordered by the General Committee to be printed *in extenso*.

The purpose of the reservoirs on the Bann is not to prevent floods, which, so far as we are aware, were never particularly disastrous on that river, but to equalise the flow of the river for water-power. "In 1835 the principal mill-owners formed themselves into a provisional committee to take steps to procure a better and more regular supply of water by the construction of reservoirs. They placed the matter in the hands of Sir William Fairbairn, who, assisted by J. F. Bateman, Esq., surveyed the collecting grounds of the river Bann and its several tributaries." Under their advice two reservoirs were constructed at Lough Island Reavy and Corbet Lough.

The Lough Island Reavy reservoir is 250 acres in extent, and contains 270,000,000 cubic feet. It cost 15,000*l.* to construct, besides 6,000*l.* for land. It is 430 feet above the sea-level, and is supplied by two mountain-streams. Its drainage area, including the lake itself, is only about five square miles, and it is filled and emptied only once in the year.

The Corbet reservoir is lower down than the other, and is chiefly filled from the Bann itself. Its extent is 70 acres, and its capacity 28,000,000 cubic feet. It "has been of much more service than its capacity would lead one to expect, as it may be filled and emptied four or five times in each year by small floods in the river, and all the Sunday water can be sent into it, and let down to the mills on Monday and Tuesday. It is generally exhausted before the upper reservoir is called on, and keeps up a supply when there is a scarcity in frosty weather."

The purpose of regulating the supply has been tolerably well attained. "A register of the daily height of the water in Lough Island Reavy has been kept since 1847. It shows that this reservoir has been of great service, as during 26 years an average supplementary supply of about two-fifths of the standard summer discharge allowed over Ervin's Weir, or about 30 cubic feet per second, has been granted, for, on an average, 102 days yearly: and the reservoir has been empty, on an average, eleven and a half days yearly." "The register of the Corbet reservoir has not been kept so long or so accurately as that of Lough Island Reavy; from the average of three years, however, and comparison with the register of Lough Island Reavy, I calculate it has given 120,000,000 cubic feet in the year, exactly one half that of Lough Island Reavy, or a good supply for fifty-one days; add to this the Lough Island Reavy supply, and there is a total of 153 days of twenty-four hours each." "As the supply from the reservoirs has only failed, on an average, eleven and a half days yearly, the standard water power may be said to have been almost constantly maintained:—indeed it is almost as good as steam-power, but at much less cost."

The income of the Company which has made the reservoirs is derived from a charge authorised by their Act of Parliament of 10*l.* per annum per foot of fall occupied by manufactories, and half of this when occupied by flax scutching mills and country corn-mills. The total fall from the upper reservoir to the bottom of the lowest fall is 350 feet, of which 180 are occupied by machinery. The capital of the Company is 31,000*l.*, and the dividend about three per cent., with a certainty of increase, if the advance in the price of coals, and the expected opening of the higher part of the district by railway, lead to more of the falls being occupied.

We think the calculations we have quoted from the American engineer, and the example of what has been done on a comparatively small scale in Ireland, are enough to show that the most difficult problems of the regulation of the flow of rivers may be approached with great hope of success.

*THE GIGANTIC LAND TORTOISES OF THE MASCARENE AND GALAPAGOS ISLANDS**

II.

ALTHOUGH the island of Aldabra is a British possession, its distance from the Mauritius and the Seychelles renders a supervision on the part of the Government very difficult, and no control whatever can be exercised on crews of ships who land there chiefly for the purpose of cutting wood, which they require for curing fish, &c. Information having reached England in the course of last year that it was intended to lodge permanently wood-cutting parties on the island, the speedy extinction of the tortoises seemed imminent; and the time to prevent this seemed all the more opportune, as the then Governor of the Mauritius, Sir Arthur Gordon, was known to take great interest in all matters relating to natural history. Consequently the following memorial was addressed to him, signed by the presidents of the Royal and Royal Geographical Societies, and other men of science who had made researches into the extinct fauna of these islands:—

To His Excellency the Hon. Sir Arthur Hamilton Gordon, K.C.M.G., Governor and Commander-in-Chief of Mauritius and its dependencies.

We, the undersigned, respectfully beg to call the attention of the Colonial Government of Mauritius to the imminent extermination of the Gigantic Land Tortoises of the Mascarenes, commonly called "Indian Tortoises."

2. These animals were formerly abundant in the Mauritius, Réunion, Rodriguez, and perhaps other islands of the western part of the Indian Ocean. Being highly esteemed as food, easy of capture and transport, they formed for many years a staple supply to ships touching at those islands for refreshment.

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* The substance of this article is contained in a paper read by the author before the Royal Society in June, 1874, which will appear in the forthcoming volume of the "Philosophical Transactions," and to which I must refer for the scientific portion and other details. Some facts which have come to my knowledge subsequently to the reading of this paper, are added. Continued from p. 239.

3. No means being taken for their protection, they have become extinct in nearly all these islands, and Aldabra is now the only locality where the last remains of this animal form are known now to exist in a state of nature.

4. We have been informed that the Government of Mauritius have granted a concession of Aldabra to parties who intend to cut the timber on this island. If this project be carried out, or if otherwise the island is occupied, it is to be feared, nay certain, that all the tortoises remaining in this limited area will be destroyed by the workmen employed.

5. We would, therefore, earnestly submit it to the consideration of Your Excellency whether it would not be practicable that the Government of Mauritius should cause as many of these animals as possible to be collected before the wood-cutting parties or others land, with the view of their being transferred to the Mauritius or the Seychelle Islands, where they might be deposited in some enclosed ground or park belonging to the Government, and protected as property of the Colony.

6. In support of the statements above made and the plan now submitted to the Mauritius Government, the following passages may be quoted from Grant's "History of Mauritius" (1801, 4to.):—

"We (in Mauritius) possess a great abundance of both land and sea turtle, which are not only a great resource for the supply of our ordinary wants, but serve to barter with the crews of ships" (p. 194).

"The best production of Rodriguez is the land-turtle, which is in great abundance. Small vessels are constantly employed in transporting them by thousands to the Isle of Mauritius for the service of the hospital" (p. 100).

"The principal point of view (in Rodriguez) is, first, the French Governor's house, or rather that of the Superintendent, appointed by the Governor of the Isle of France, to direct the cultivation of the gardens there and to overlook the park of land-turtles. Secondly, the park of land-turtles, which is on the sea-shore facing the house." (p. 101.)

7. The rescue and protection of these animals is, however, recommended to the Colonial Government less on account of their utility (which nowadays might be questioned in consideration of their diminished number, reduced size, and slow growth, and of the greatly improved system of provisioning ships which renders the crews independent of such casual assistance), than on account of the great scientific interest attached to them. With the exception of a similar tortoise in the Galapagos Islands (now also fast disappearing), that of the Mascarenes is the only surviving link reminding us of those still more gigantic forms which once inhabited the Continent of India in a past geological age. It is one of the few remnants of a curious group of animals once existing on a large submerged continent, of which the Mascarenes formed the highest points.

It flourished with the Dodo and Solitaire, and whilst it is a matter of lasting regret that not even a few individuals of these curious birds should have had a chance of surviving the lawless and disturbed condition of past centuries, it is confidently hoped that the present Government and people who support the "Natural History Society of Mauritius" will find the means of saving the last examples of a contemporary of the Dodo and Solitaire.

London, April 1874

[*Hree follow the signatures.*]

This memorial was most favourably received by Sir A. Gordon, who in his reply states that, although the intention of conceding the island to parties for the purpose of cutting wood had not yet actually been carried out, the extermination of the tortoises is proceeding quite as rapidly as if this were the case. Not only are the animals destroyed by the whalers, but (as he was informed by visitors to the island) the pigs, which are supposed to have been left there by a passing ship some years ago, and which have rapidly multiplied, turn up the eggs in great numbers, and even devour the very young tortoises. The lessee should be bound to protect the animals and to remit annually to Mauritius a pair of living ones which, with others acquired by purchase, would be preserved in a paddock of the Botanic Gardens at Pamplemousses. He adds that in several of the Seychelle Islands such paddocks exist, the young tortoises being esteemed as articles of food; at four years they appear to be considered fit for eating; but he never observed that any are allowed to grow up as breeding stock to replace the original pair.

We confidently hope that Sir A. Gordon's successor will not lose sight of this matter and that the Royal Society of Arts and Sciences of Mauritius, to whom a copy of the memorial has been sent, with the request to support the appeal of their fellow-labourers in England, will recognise it as one of their duties to watch that the existence of one of the most interesting animal types within the limits of their own special domain, is not only prolonged but insured for all times.

We owe it chiefly to the kind mediation of Sir A. Gordon that a living pair of the Aldabra Tortoises are at present in London. Anxious to acquire this pair for the collection of the British Museum, the male being known to be the finest individual of the species in existence, I requested Sir A. Gordon to assist me in their acquisition, the owner being at first reluctant to part with them. To the excellent arrangements of the Hon. C. S. Salmon, Chief Commissioner of the Seychelles, and to the most fortunate circumstance that Dr. Brooks, the Government Medical Officer, accompanied and took charge of the animals on their journey to Europe, we have to thank that they arrived in the most perfect state of health. The Zoological Garden being clearly the most appropriate place for them during their lifetime, I handed them over to the Zoological Society, and have no doubt that, with the interest taken in this subject by Mr. Sclater, and with the care bestowed on them by Mr. Bartlett, these animals have a better chance of surviving their transmission into our severe climate than the specimens imported some thirty or forty years ago.* Mr. Salmon writes that both the tortoises are natives of Aldabra, though not of the same breed. The larger, the male, has been in the Seychelles for about seventy years; its last proprietor, M. Deny Calais, kept it with the female in a semi-domesticated state on Cerf Island. His weight is about 800 lbs.; the length of the shell 5 ft. 5 in. (in a straight line), the width 5 ft. 9 in.; † circumference of the shell, 8 ft 1 in.; circumference of fore leg, 1 ft. 11 in., and of hind leg, 1 ft. 6 in.; length of head and neck, 1 ft. 9 in.; width of head, 6 in. The female is much smaller, and I have no information as regards the time she was brought to the Seychelles. The length of her shell is 3 ft. 4 in., the width 3 ft. 10 in., the circumference 5 ft. 4 in. She lays thrice every year, in the months of July, August, and September, each time from fifteen to twenty round hard-shelled eggs. There is every reason to believe that the laying of eggs will not be interrupted by the transmission of the animals to England.

Every one who sees these two tortoises side by side is at once struck by the great difference in form and sculpture of the shell. That of the male is remarkably high, with a rounded outline, each plate being raised into a hummock, and deeply sculptured with concentric furrows along the margins. The female, on the other hand, has a perfectly smooth shell with an oval outline, without either furrows or raised portions. The shell of the male is brownish, that of the female black. The male has also a comparatively longer neck and tail than the female. It is quite possible that these are sexual differences, the males being known to grow to a much larger size than the females. But as Aldabra consists of three islands, separated by channels of the sea which are impassable barriers to animals which may float but cannot swim, it may be presumed that the two animals come from distinct islands, each island of the group being inhabited by a distinct race, as in the Galapagos. This is a question

* I have kept young specimens of the Aldabra Tortoise (two of which are the offspring of the very individuals now imported), as well as half-grown ones of the Galapagos species, for years. Want of water and a twenty-four hours' exposure to a temperature below 50° are fatal to them. In the autumn and winter they must be kept in a greenhouse where the temperature should be kept at about 70°. With a plentiful and varied supply of vegetables, they thrive well and grow perceptibly.

† A large example, probably of the Rodriguez species, which formerly lived in the Zoological Gardens, and is described in Proc. Zool. Soc., 1833, p. 81, weighed 289 lbs., the shell being 4 ft. 4¼ in. in length (over the curve), and 4 ft. 9 in. in width.

the investigation of which I would particularly recommend to persons visiting Aldabra.

Mr. Salmon states that the male shows himself to be annoyed when the female is disturbed, and there is no doubt that he exhibits affection for her, as was especially evident on board the steamer, when he tried to break out of his cage as soon as he got sight of the female, who was transported in a separate cage. The circumstance that the two animals are a pair, increases the chances in favour of their being kept alive for a lengthened period. And they will be well worth all the care we can bestow on them, as it is extremely doubtful whether we shall ever succeed again in obtaining a pair of full-grown examples. The male is without doubt the largest and most powerful individual of its race, far exceeding in size any of the few other individuals kept in the Seychelles. Nor is it likely that in Aldabra itself a similarly large example should have succeeded in evading the search of the numerous crews which have landed there.

From the historical evidence given above, it is evident :

1. That the presence of the Gigantic Tortoises at two so distant stations as the Galapagos and Mascarenes cannot be accounted for by the agency of man, and therefore that these animals must be regarded as indigenous.

2. That, although frequently transported by the early navigators to distant and apparently suitable localities (Sandwich Islands, Masa Fuero, and Ceylon), they never established themselves permanently, but there is no evidence to show whether this failure is due to an innate inability of the species to become acclimatised when far removed from its native place, or to the destructiveness of the inhabitants of those localities.

3. That the different islands of the Galapagos group were inhabited by distinct races.

4. That possibly the animals even of so small a group as Aldabra were differentiated in the different islands.

5. That although these animals are still lingering in the Galapagos and Aldabra their numbers are yearly diminishing, and that their growth to perfect maturity is interrupted; that with respect to the races of the Galapagos Tortoise, the elucidation of the irdistinctive characters and original distribution, we are, and probably shall be, dependent chiefly on the materials already preserved in zoological museums.

6. That the Tortoises of Mauritius and Rodriguez are entirely extinct. It is probable that in some museums shells, or even entire animals of these once so numerous races exist, but it will be a matter of great difficulty to trace their origin; therefore our examination is limited at present to the osseous remains transmitted from the Mauritius and Rodriguez. ALBERT GÜNTHER

(*To be continued*)

NOTES

WE are glad to hear that both a zoological and botanical collector will form part of the retinue of the Prince of Wales, in his approaching visit to India.

DR. VOGEL (not the photographer of that name), the Director of the newly established "Sonnenwarte" of Berlin, is now in this country.

THE rate of propagation of the recent inundation waves in the south of France has been determined along the banks of the Garonne. It was found to have been no more than two miles an hour in a run of 140 miles in the district where the principal calamities occurred. The consequence is that an immense amount of property and life could have been saved if a system of warnings had been adopted. Wise as usual after the event, the authorities intend to establish such a system as is already in operation at Lyons for the Rhône, and at Paris for the Seine. In an article in the July number of *Symons's Monthly Meteorological Magazine*, on the French floods, is an interesting calculation which will give Londoners some idea of what a "flood" means. Supposing we had a flood in the Thames, it would cover on the south bank, the whole of Battersea Park, Lambeth, Southwark, Bermondsey, and Deptford; and on the north bank, Fulham, Chelsea, Brompton, Belgravia, Westminster, and St. James's Park; while, as for the new embankment, a steamer might ply over the top of it.

IT is suggested that the unusual violence of the floods on the continent are attributable not only to the abnormal amount of rain and the sudden melting of snow and ice in the mountain districts, but also to the increasing destruction of forests which is taking place in nearly every country. For some years past the violence of the spring and summer floods has been increasing, and it is remarkable that this increase in their force is contemporaneous with the gradual extinction of forests and woodlands. The existence of forests has a great effect in equalising the distribution of water, and in checking the too rapid melting of snow and ice under the influence of the summer heat. At the same time the growth of timber on hill sides prevents the rapid flow of surface-water which takes place where trees do not exist. The question of maintaining forests, instead of destroying them, without making provision for the future, is one which demands the serious attention of the governments of every country, and particularly of those countries where, by the existence of hills and mountains, and consequently rapid rivers, the liability to floods is increased.

WE have been informed that during the recent very bad weather there has been an unusual number of icebergs met with in the North Atlantic, and that fogs in Labrador and Newfoundland have been extraordinarily severe and frequent. It is to be hoped that some general inquiry into the recent peculiar weather and its accompaniments will be instituted; no doubt valuable results would be obtained.

THE Austrian Commission to the International Geographical Exhibition has intimated that they intend to present to the French Geographical Society all the books they are exhibiting. As this example will, we are informed, be followed by other Commissions, a magnificent Geographical Library will be one of the results of the meeting of the Congress.

THE work of the Sub-Wealden Exploration is temporarily arrested at 1,672 feet from increasing deposit from the sandy beds. The original problem was dependent on the opinion of geologists that palæozoic rocks would be found at a depth varying from 700 to 1,700 feet. So far, however, the strata are mesozoic; but the latest fossils give some indications of a palæozoic rock. Much hope is therefore entertained of solving the problem.

PARTS 19 to 24 of the quarto work published by authority of the Lords Commissioners of the Admiralty, on the Zoology of the Voyage of H.M.S. *Erebus* and *Terror*, conclude the descriptions of the Mammalia by the late Dr. J. E. Gray, F.R.S.; the Birds by Mr. R. B. Sharpe; the Reptiles by Dr. A. Günther, F.R.S.; and the Insecta by Mr. A. G. Butler. Part 20 is by Mr. E. J. Miers on the Crustacea, and Part 21 by Mr. E. A. Smith on the Mollusca.

THE Rev. E. Ledger, M.A., rector of Duxford, Cambridgeshire, was yesterday elected to the Gresham Professorship of Astronomy in the City of London. Mr. Ledger was a Carpenter and Beaufoy Scholar of the City of London School, and afterwards Fellow and Lecturer of Corpus Christi College, Cambridge. He was fourth Wrangler in 1863, and also University Scholar of the University of London.

AN International Horticultural Exhibition and Congress is to be held in Amsterdam in 1876, similar to the one held in Florence last year. A strong committee has been appointed, who desire the co-operation of the various horticultural societies throughout Europe in making the undertaking as complete and successful as possible. The President is to be Mr. J. H. Krelage, and the Secretary Mr. H. Groenewegen.

MR. THISELTON DYER, in consequence of his recent appointment to Kew, has resigned the Professorship of Botany at the Royal Horticultural Society.

DR. HOFFMANN, of Giessen, contributes an interesting article on the influence of inland-water on the vegetation of shore-lands to the *Oesterreichisches Landwirthschaftliches Wochenblatt* of July 10. His object is to prove that large bodies of water tend to produce an equable climate, and that a large percentage of heat and light is due to the reflected rays of the sun from the surface of the water. To illustrate his argument he selects that part of the river Rhine which flows from east to west, from Biebrich to Niederwald, where the northern bank more particularly in the immediate vicinity of the water produces the best grapes in Germany. Moreover, he states that the fogs rising from the water in the month of May protect the tender shoots of the vine from being injured by late frosts. This, at any rate, does not agree with our experience in this country.

IT is stated that, in consequence of pressure of business, the Government is not likely to be in a position, during the present session, to return any final answers to the applications for aid made on behalf of King's College, London; Owens College, Manchester; the University College of Wales; and other educational bodies throughout the country.

LORD ABERDARE has been elected President of the Social Science Association for the ensuing year.

IN a pit about half a mile east of Erith Railway Station, where an old and deserted bed of the Thames is excavated for brick earth, and which has yielded the bones of two species of British elephant and one of lion, Dr. Gladstone, F.R.S., was so fortunate as to find, on Saturday last, a large flint implement of palæolithic make. The implement is seven inches in length, slightly convex, and chipped on the outer curve with three longitudinal faces; consequently it has four working edges. At the butt end an echinus, or sea urchin, is embedded in the flint.

IN some excavations which have recently been undertaken during the construction of the continuation of the Thames embankment westwards, some probably prehistoric remains have been brought to light, which include a human lower jawbone with all the teeth present. At about the same spot a flint knife was discovered and other animal remains, some mixed with freshwater shells.

IN the Proceedings of the Bristol Naturalists' Society (Vol. I. Part ii.) will be found the translation, by Dr. Fripp, of a valuable paper by Dr. E. Abbe, of Jena, entitled, "A Contribution to the Theory of the Microscope, and the Nature of Microscopic Vision."

THE University of California has organised a summer exploring party, which will be occupied about nine weeks in journeying through the Sierra Nevada Mountains in Mariposa, Mono, and Inyo counties, and will bestow particular attention to geology, palæontology, and mineralogy. The party will be in charge of Dr. Joseph Le Conte, assisted by Mr. Henry Edwards, Mr. F. P. M'Lean, and Mr. F. Slate.

SIR CHARLES LOCOCK, Bart., F.R.S., First Physician-Accoucheur to the Queen, died on Friday last, at the age of seventy-six years.

THE British Archæological Association meets this year at Evesham, on Monday, August 16, when the President, the Marquis of Hertford, will deliver the inaugural address.

A REUTER'S telegram states that an attack has been made on the Palestine exploring party, none of whom have, however, been hurt. The assailants were repulsed.

THE rector of the Catholic University of Louvain (Belgium) has gone to Paris in order to consult with the ecclesiastics now engaged in preparing to establish a Catholic University in that city. The site has been already chosen, and is close to the place where *La Bastille* was erected during the old Monarchy. The liberals are not likely to establish a University of their own, if the existing University satisfies their principal claims.

A CAPITAL weekly journal, the *Electrical News and Telegraphic Reporter*, whose first appearance we intimated a few weeks ago, has just completed the first month of its existence. It is edited with care and ability by Mr. Crookes, and is uniform in size and price with the *Chemical News*. In the number for July 22 there are nine articles of considerable scientific value and others of no less general interest. We notice especially the paper on Quadruplex Telegraphy and the Telegraph in China. The notes are interesting, and the reports of electrical science from the foreign journals are well done. We are glad to be able to bring this useful journal under the notice of our readers.

AN examination will be held at Exeter College, Oxford, on Thursday Oct. 14, for the purpose of election to two scholarships in Natural Science, of the annual value of 80*l*. each, tenable for five years.

WE have received the "Second Appendix" to the "Flora of Liverpool," issued by the members of the Field Club. It contains additional habitats for many species, and also includes several species not previously recorded as growing in the district, some of them of considerable rarity, as: *Ranunculus fluitans*, *Barbarea stricta*, *Carduus nutans*, *Doronicum Pardalianches*, *Cusenta Europæa*, *Mentha rubra*, *Stachys ambigua*, *Atriplex triangularis*, *Rinnex pratensis*, *Alisme natans*, *Carex divulsa*, *axillaris* and *fulva*. Local "floras" are becoming so numerous now, and the directions for finding certain plants so minute, that there is some point in the remark of a facetious foreign professor of botany, who said that we should soon have have all our British plants separately labelled. This defect (in our opinion) is rather conspicuous in the Appendix to the Flora of Liverpool. It may be desirable to know something about the number of individuals of exceedingly rare though undoubtedly indigenous species.

MR. DALL has presented a report to the United States Coast Survey on the tides, currents, and meteorology of the Northern Pacific. He finds proof of the existence of a northerly current, denominated by him "the Alaska current," which had previously been surmised.

VOL. VI. of Mr. F. V. Hayden's Report of the U.S. Geological Survey consists of a monograph, by Mr. Leo Lesquereux on the Cretaceous Flora of the Western Territories, profusely illustrated. Mr. H. Gannett, under the same direction, has issued the third edition of a List of Elevations west of the Missouri River.

THE additions to the Zoological Society's Gardens during the past week include, a Chimpanzee (*Troglodytes niger*) from W. Africa, presented by Capt. Lees, Govenor of Lagos, W. Africa; three Amherst Pheasants (*Thaumalea amherstiæ*); a Geoffroy's Blood Pheasant (*Ithaginis Geoffroyii*) and five Temminck's Tragopans (*Ceriornis Temminckii*) from China, deposited; a Sambur Deer (*Cervus aristotelis*), two Brown Indian Antelopes (*Tetraceros subquadricornutus*) from India, a Tora Antelope (*Alcelaphus tora*) from Upper Nubia, an Elate Hornbill (*Buceros elatus*), an Electric Silurus (*Melapterurus beninensis*) from W. Africa, a Naked-throated Bell Bird (*Chasmorhynchus nudicollis*), a Pectoral Tanager (*Ramphocœlus brasilius*), a Festive Tanager (*Calliste festiva*) from Brazil, purchased.

SOCIETIES AND ACADEMIES

London

Geological Society, June 23.*—Mr. John Evans, V.P.R.S., president, in the chair.—On the Granitoid and associated Metamorphic Rocks of the Lake-district, by J. Clifton Ward.

Part I. *On the Liquid Cavities in the Quartz-bearing Rocks of the Lake-district.*—The object of this paper was to examine into the evidence afforded by the liquid cavities of the granitoid rocks of the Lake-district, with reference to the pressure under which these rocks may have consolidated. In the first division of the subject the geological relations of the three granitic centres of the district were considered, and it was shown that these several granitic masses probably solidified at depths varying from 14,000 feet to 30,000 feet. The most probable *maximum* depth for the Skiddaw granite was stated as 30,000 feet; the *maximum* for the Eskdale granite 22,000 feet; and for the Shap granite 14,000 feet. These maximum depths were arrived at by estimating the greatest thickness of strata that were ever, at one time, accumulated above the horizon of the top of the Skiddaw slates. The mode of microscopic examination, together with a description of the precautions taken in measuring the relative sizes of the cavities and their contained vacuities, formed the second division of the paper. It was stated that all the measurements used in the calculations were made from cases in which the vacuity mixed freely in the liquid of the cavity, and an approximately *perfect* case for measurement was defined to be one in which the outline of the liquid cavity was sharply defined all round in one focus, and in which the vacuity moved freely to every part of the cavity *without going out of focus*. Then followed the general results of the examination. Restricting the measurements to such cases as those above mentioned, the results were found to be generally consistent with one another, and with those previously obtained by Mr. Sorby in his examination of other granitic districts. From the fact that the calculated pressure in feet of rock was in all cases greatly in excess of the pressure which could have resulted from the thickness of overlying rocks, it was inferred as probable that these granitic masses were not *directly* connected with volcanic action, by which the pressure might have been relieved, but that the surplus pressure was spent in the work of elevation and contortion of the overlying rocks. Microscopic, combined with field evidence, was thought to indicate that the Shap granite, though mainly formed at a depth similar to that at which the Eskdale granite consolidated, was yet itself finally *consolidated* at a much less depth, the mass having eaten its way upwards at a certain point, and perhaps representing an unsuccessful effort towards the formation of a volcanic centre. The examination showed that the *mean* of the pressures under which the Lake-district granites probably consolidated was nearly the same as the *mean* which Mr. Sorby arrived at for those of Cornwall. In conclusion the author stated that he wished these results to be considered as preliminary only, since the *complete* investigation would necessarily occupy far more time than was at his disposal; at the same time he ventured to hope that *general* accuracy was insured, while pointing to the many little-known causes which might affect the conclusions.

Part II. *On the Eskdale and Shap Granites, with their associated Metamorphic Rocks.*—The author brought forward evidence in this paper to prove the possibility of the formation of granite by the extreme metamorphism of volcanic rocks. The passage is shown in the field, and may be observed in a complete series of hand specimens. Frequently, indeed, the actual junction is well marked, but in other cases the transition is gradual; and there occur at some little distance from the main mass, inlying patches of what may be called bastard granite. The microscopic examination proves the passage from a distinctly fragmentary (ash) to a distinctly crystalline rock, and to granite itself. Also the chemical composition of the altered rocks agrees very closely with that of the granite. Both Eskdale and Shap granite were believed to have been formed *mainly* from the rocks of the volcanic series by metamorphism at considerable depths; but the granite of Shap was thought to be in great measure intrusive amongst those particular beds which are now seen around it. A decided increase in the proportion of phosphoric acid was noted in the volcanic rocks on approaching the granite, and a decrease in carbonic acid.

On the Correlation of the Deposits in Cefn and Pontnewydd Caves, with the Drifts of the neighbourhood, by Mr. D. Mackintosh. Believing that the time has arrived for making some attempt to correlate cavern-deposits with glacial and interglacial drifts, the author ventures to bring forward the results of a personal examination of the remnants of the deposits in Cefn and Pontnewydd caves, compared with old accounts given by Mr. Joshua Trimmer and others. He has been led to regard the following as the sequence of deposits before the caves were nearly cleared out (order ascending):—1. Loam with bones and smoothly rounded pebbles, nearly all local (cemented into conglomerate in Pontnewydd cave). As a few foreign pebbles of felstone have been found in this bed, it could not have been deposited by the adjacent river Elwy before the great glacial submergence; and the author gives reasons for believing that it was not introduced by a freshwater stream from the boulder-clay above in Post-glacial times, but that it may possibly represent the middle drift of the plains, and may have been washed in by the sea during the rise of the land. After emergence, and during a comparatively mild interglacial period, bones of animals may have been introduced by rain through fissures in the roof of the cave, and these may have become partly mixed up with the underlying pebbly deposit. 2. Stalagmite, from less than an inch to two feet in thickness, accumulated during a continuance of favourable conditions (apparently absent in Pontnewydd cave). Bones of animals were again brought in by rain or by hyænas, and were afterwards worked up into the following deposit:—3. Clay, with bones, angular and subangular fragments of limestone, pebbles of Denbighshire sandstone, felstone, &c. (palæolithic flint implements and a human tooth in Pontnewydd cave according to Prof. T. M'Kenny Hughes). This clay once filled the Cefn cave nearly to the roof. There are reasons for believing that it was principally introduced through the mouth of the cave, that it is of the same age with the neighbouring upper boulder-clay, and that it is not a freshwater redeposit of that clay. It was probably washed in during a second limited submergence. 4. Loam and coarse sand charged with minute fragments of sea-shells. Portions of this deposit may still be found in the Cefn cave; and it may have been introduced through fissures in the roof by the sea as the land was finally emerging.

Geological Notes from the State of New York, by Mr. T. G. B. Lloyd, C.E. The substance of this paper comprises notes, accompanied by drawings and sketches of various matters of geological interest which fell under the author's observation whilst residing some years ago in the State of New York. The different subjects are divided under the following heads:—(1) Groovings and channelings in limestone running across the bed of Black River at Watertown, Jefferson co. (2) Descriptions of the superficial beds of boulder-clay, sand, and gravel which were exposed to view in the district around the village of Theresa during the construction of the Black River and Morristown railroad. (3) A description, with a general and detailed drawing to scale, of a remarkable "Giant's Kettle" near Oxbow, in Jefferson co. (4) An account of some peculiar flower-pot-shaped blocks of sandstone discovered in a quarry of Potsdam sandstone at the village of Theresa. The author in conclusion refers to a statement in a paper on Niagara by Mr. Belt, F.G.S., published in the *Quart. Journ. of Science* for April 1875, in which it is stated that the sections described as occurring near the Falls are typical of the superficial beds that mantle the whole of the northern part of the State of New York and Ohio and much of Canada. He is unable to find any description of a deposit which bears a near resemblance to the boulder-clay occurring in the district around the village of Theresa, in the descriptions of various authors of the superficial deposits of the northern part of the State of New York and Canada. He therefore ventures to remark that no section can be considered as typical of the whole of the north part of the State of New York which does not recognise the existence of the deposit in question.

On a Vertebrate Fossil from the Gault of Folkestone, which also occurs in the Cambridge Greensand, by Prof. H. G. Seeley, F.L.S. The author describes a bone having the general form of an incisor tooth obtained from the Gault of Folkestone by Mr. J. S. Gardner, F.G.S. The flattened cylindrical end of a specimen from the Cambridge Greensand has been figured as a caudal vertebra of *Pterodactylus simus*. A microscopic section of the expanded end of a specimen from the Cambridge Greensand exhibits ordinary osseous tissue, showing that the fossil is probably a dermal spine from the tail of a Dinosaur. The Gault specimen is smaller than the examples from Cambridge.

Royal Horticultural Society, July 7.—Scientific Committee.—J. D. Hooker, F.R.S., in the chair.—A paper on the resting-spores of the potato disease was read by Worthington

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* Continued from p. 243.

Smith, F.L.S. These were identified with the bodies which Mr. Berkeley had lately regarded as a species of *Protomyces*, and the cause of a new malady in the potato. The following are the principal points in this very important communication :—On receiving authentic specimens of diseased plants from Mr. Barron, Gardener-in-Chief to the Society, the brown spots on the potato-leaves at once called to mind the figures of some species of *Protomyces*, and the dimensions agreed tolerably well with some described plants of that genus, but the spots, when seen under a high power, appeared very unlike any fungus, and they were very sparingly mixed with other bodies much smaller in diameter, and with a greater external resemblance to true fungus spores. These latter spore-like bodies were of two sizes—one transparent and of exactly the same size as the cells of the leaf (and therefore very easily overlooked), and the other dark, reticulated, and much smaller. A few mycelial threads might be seen winding amongst the cellular tissue. The author's opinion, therefore, was soon formed that the "new" potato disease was no other than the old *Peronospora infestans* in an unusual and excited condition. That climatic conditions had thrown the growth of this fungus forward and out of season was probable; but the idea that the pest would not at length attack all and every sort of potato seemed unreasonable, though the more tender sorts might be the first to suffer. From day to day the diseased leaves and stems and tubers were kept between pieces of very wet calico, in plates under glass, and it was immediately noticed that the continued moisture greatly excited the growth of the mycelial threads. So rapid was now the growth of this mycelium, that after a week had elapsed some decayed parts of the lamina of the leaf were traversed in every direction by the spawn. In about ten days the mycelium produced a tolerably abundant crop, especially in the abortive tubers, of the two-sized bodies previously seen in the fresh leaves. The larger of these bodies Mr. Smith was disposed to consider the "oospore" of the potato fungus, and the smaller bodies as the "antheridia" of the same fungus, which are often terminal in position. The filaments of the latter are commonly much articulated, and sometimes more or less moniliform or necklace-like. Both oospore and antheridium are very similar in nature and size to those described as belonging to *Peronospora alsinearum* and *P. umbelliferarum*, and this is another reason (beyond the occurrence of undoubted *P. infestans* on potato-leaves at the beginning of June) why he was disposed to look upon these bodies as the oospore and antheridium of the potato fungus. The larger bodies are at first transparent, thin, pale brown, furnished with a thick dark outer wall, and filled with granules; at length a number (usually three) of vacuities or nuclei appear. The smaller bodies are darker in colour, and the external coat is marked with a few reticulations, possibly owing to the collapsing of the outer wall. At present he had been unable to detect any fecundating tube (described as belonging to the antheridium of other species of *Peronospora*), but he had observed the two bodies in contact in several instances. After fertilisation has taken place, the outer coat of the oospore enlarges, and appears to be cast off. Both antheridium and resting-spore are so slightly articulated to the threads on which they are borne that they are detached by the slightest touch, but with a little care it is not really difficult to see both bodies *in situ*; and my observations lead me to think that conjugation frequently takes place after both organs are quite free. The antheridia and oospores are best seen in the wettest and most thoroughly decomposing tuber, but they occur also in both the stem and leaf. The author was also disposed to regard Montagne's *Artotrogus* as identical with the resting-spore of *Peronospora infestans*, an opinion which had long been held by Mr. Berkeley.

PARIS

Academy of Sciences, July 19.—M. Frémy in the chair.—The following papers were read :—On M. Espy's meteorological theory, by M. Faye.—On the continuation which it will be necessary to make of experimental researches on plasticodynamics, by M. de Saint-Verant. This new branch of mechanics treats of the internal motions of solid bodies in a state of plasticity. M. Tresca added some remarks on the same subject.—Experimental and clinical considerations on the nervous system with regard to its function in actions governed by the sensitive, instinctive and intellectual faculties, as well as in the so-called voluntary locomotive actions, by M. Bouillaud. The author arrives at the following conclusions :—The cerebrum and the cerebellum are both absolutely necessary for all actions which are governed by the various faculties of mind or intelligence. The cerebellum is the seat of co-ordination of the movements of walking, the cerebrum being the seat of the co-ordinating centres of the movements necessary for the execution of a great number of intellectual actions, speech in particular.—On a distinction between natural and artificial organic products. The author repeats the distinction made by him in 1860, in reply to a statement by M. Schutzenberger. This distinction is that natural bodies are always unsymmetrical.—Observations relating to M. Hirn's communication of June 23. Importance of basing the new theory of heat on the hypothesis of the vibratory state of bodies, by M. A. Ledieu.—Note on the chronology and geography of the plague in the Caucasus, in Armenia, and in Anatolie during the first half of the nineteenth century, by M. J. D. Tholozan.—On the development of the spiny rays in the scale of *Gobius Niger*, by M. L. Vaillant.—On d'Arrest's periodic comet, by M. Leveau.—Observations of Jupiter's satellites during the oppositions of 1874 and 1875. Determination of their differences of aspect and of their variation of brilliancy, by M. Flammarion. In size the decreasing order is III., IV., I., II. Intrinsic luminosity for equal surfaces I., II., III., IV. Variability in decreasing order IV., I., II., III.—Note on magnetism; reply to an observation of M. Jamin, by M. J. M. Gaugain.—Oxy-uvitic and the cresol derived from it, by MM. A. Oppenheim and S. Pfaff. The cresol is metacresol.—On a compound of methyl oxide and hydrochloric acid, by M. C. Friedel.—On the diethylic ether of xanthoacetic acid, by MM. C. O. Cech and A. Steiner.—On the estimation of carbon disulphide in the sulphocarbonates of potassium and sodium, by MM. David and Rommier.—On the mode of action of the pillars of the diaphragm, by M. G. Carlet.—On the reproduction of eels, by M. C. Dareste.—The morphological elements of the oblong leaves of the monocotyledons, by M. D. Clos.—On a claim of priority relative to a fact of botanical geography, by M. Ch. Contejean.—During the meeting M. Mouchez was elected a member of the Astronomical section to replace the late M. Mathieu.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Chambers' Encyclopædia. 10 vols., new and revised edition (W. and R. Chambers).—Reports of the Medical Officer of the Privy Council and Local Government Board. New Series, No. 3 (Spottiswoode).—On the Inequalities of the Earth's Surface viewed in connection with the Secular Cooling: Osmond Fisher, M.A. (Cambridge Philosophical Transactions).—Flora of Eastbourne: F. C. S. Roper, F.L.S. (Van Voorst).—Travels in Portugal: John Latouche (Ward, Lock, and Tyler).—Second Supplement to Watts's Dictionary of Chemistry (Longmans).—Transactions of the Manchester Geological Society, Vol. xiii. Part 10.—Health in the House: Catherine M. Buckton (Longmans).—Hydrology of South Africa: J. Croumbie Brown, LL.D. (H. S. King and Co.).—Rudiments of Geology: Samuel Sharp, F.S.A., F.G.S (E. Stanford). The Skull and Brain; their Indications of Character and Anatomical Relations: Nicholas Morgan (Longmans). North Staffordshire Naturalists' Field Club Addresses, Papers, &c.—On the Sensations of Tone as a Physiological Basis for the Theory of Music, by H. Helmholtz; translated by A. J. Ellis, F.R.S. (Longmans).—Reports and Proceedings of the Miners' Association of Cornwall and Devon for 1874.

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ERRATA.—Page 232, col. 1, line 24 from bottom, for "currents" read "cumuli"; line 22 from bottom, for "lovely" read "lowly."

THURSDAY, AUGUST 5, 1875

AMERICAN GEOLOGICAL SURVEYS

THE United States of America have certainly done noble work in the exploration and mapping of their vast empire. Most of the long-settled States have for many years possessed elaborate maps and reports upon the topography, geology, and agricultural features of their territory. The central Government has likewise carried on extensive and admirable coast surveys, besides innumerable expeditions and surveys for opening up the less known or wholly unvisited regions of the interior of the continent. Were all the literature connected with this subject gathered together it would be found to form of itself a goodly library. Some of it has been published in most costly and indeed luxurious style; other portions, and these sometimes not the least interesting or valuable, have to be unearthed from the pages of flimsily printed "blue-books." But whatever be their external guise, these narratives are pervaded by an earnestness and enthusiasm, a consciousness of the magnitude of the scale on which the phenomena have been produced, and yet a restrained style of quiet description, which cannot but strike the reader. Their writers have evidently had their feelings of awe and admiration worked sometimes up to the highest pitch, yet they contrive on the whole to present just such plain frank statements of facts as to convey clear and definite notions of the regions they describe. Though little is said about hardships and hair-breadth escapes, one can see that these bold explorers could not have accomplished what they so modestly and quietly narrate without a vast amount of privation and danger. Some of them, indeed, like poor young Loring in 1871, have lost their lives by Indian assassins, others have fallen victims to the disease and debility necessarily attendant on so much exposure. But on the whole the work seems to be healthy, and the men engaged upon it like it and keep to it.

Leaving for the present the consideration of what has been done and is now doing in the more settled States, let us turn to those vast territories lying to the west and stretching across the Rocky Mountains to the shores of the Pacific. At the beginning of this century comparatively little was known of these regions. But the Government then resolved to gather some information on the subject, and with that end despatched an expedition in 1804 which penetrated the wilderness, reached the western sea-board, and after much hardship brought back a first instalment of knowledge regarding this part of the continent. During the period preceding the year 1851, somewhere about forty exploring and survey parties were sent by the War Department into the tracts lying to the west of the Mississippi. But in the next twenty years, viz., from 1850 to 1870, the same Department conducted forty-six of these surveys, not merely for military purposes, but to aid in the general opening up of the vast unexplored territories. As a rule, however, and until comparatively recently, these expeditions could make no pretensions to geographical accuracy. Their object was merely to fix as well and as rapidly as might be the positions of main landmarks, and to collect such information as to the nature of the country as was most needful, with the view to its early settlement.

But the discovery of gold in California at once drew attention to the western slope, and awakened a strong desire to open up a better and more expeditious communication with it than had previously been in use. The Pacific Railroad was projected, and surveys were made to ascertain the best routes. In the course of these explorations much additional information was obtained, but still in such necessarily rapid work there could be little done towards accurate geographical and topographical determinations. Hence we find that prominent points were sometimes placed from three to twenty miles out of their true position. Nor could much be attempted of any value in a geological point of view. It is seldom that a single traverse of the rocks of a wide region can be understood without a knowledge of the country lying on either side of it.

In a region of which no reliable maps exist, it is of course impossible to conduct a geological survey except in connection with a topographical one. The geologists must either make their own topographical maps, or be accompanied by surveyors who do that for them. Previous to the year 1867 no special geological exploration seems to have been carried on in the territories as the work of any Government Department. But in that year no fewer than three separate and independent geological surveys were organised. One of these, under the direction of the War Department, but conducted entirely by civilians, with Mr. Clarence King at their head, made a careful examination of a tract about a hundred miles broad, stretching along the fortieth parallel, from the eastern boundary of California to the eastern slope of the Rocky Mountains. A second survey, under the direction of the Smithsonian Institution, with Mr. J W. Powell in charge, had as its task the exploration of the Colorado of the West and its tributaries. A third survey, or series of surveys, has been conducted with great zeal by the Department of the Interior over a vast range of country embracing Nebraska, parts of Colorado and New Mexico, Wyoming, Utah, Montana, and Idaho. These surveys have been under the guidance of Dr. F. V. Hayden.

There appears to have been no concert between the different Government Departments in the organisation and conduct of these various geological explorations. Each survey party was sent out as if it had the boundless wilderness to subdue without the aid of any compatriots or even the chance of seeing human beings save hostile Indians. The Territories, though vast, were not infinite, and it was to be expected that some time or other the independent survey parties should meet. This does not seem to have happened for some years. Meanwhile, however, Dr. Hayden's expedition, supported by increasingly liberal grants from Congress, was doing most excellent work, making a good general map, and at the same time bringing before the world an annual report full of most interesting and valuable and sometimes remarkably novel information regarding the geology and natural history of the regions visited. The War Department, with a far more powerful organisation, and with the help of a staff of trained civilians, was much more deliberate in its movements. Very little of its work had seen the light, though of the excellence and copiousness of that work there was no reason to doubt. As the Department had been for more than half a century in undisputed command of the exploratory expeditions of those western regions, perhaps some of its more zealous functionaries may have grown somewhat jealous of the increasing popularity of the work done by the Department of the Interior, and may have looked upon that work as an unwarrantable encroachment upon the recognised province of the military corps. Be this as it may, a chance meeting of two independent survey parties in 1873, and the fact that to a certain extent they both surveyed the same ground, led to a battle royal in the spring of last year, wherein appeared the chiefs of the Departments with President Grant at their head, military men, geologists, naturalists, topographers, and several cohorts of professors. Evidently some of the parties knew that the contest would come sooner or later, and were prepared accordingly. The first bomb-shell was thrown as it were by an outsider, on the 15th of April, 1874, when Mr. Lazarus D. Shoemaker carried a resolution in Congress requesting the President to inform the House what geographical and geological surveys were carried on by the Government in the same or contiguous areas of territory lying to the west of the Mississippi, and whether these could not be combined under one Department, or at least have their respective geographical limits defined.

The question thus raised turn out to be really whether the War Department should have entire control of the surveys, both those intended for military and those for purely civil purposes. The President replied that they would be more economically and quite as efficiently carried on by the military authorities. Not content with this recommendation of its military chief, Congress referred the matter to its Committee on Public Lands. A careful investigation followed, and though the military side fought hard for its supremacy, the Committee decided against the purposed consolidation. Their conclusions ran thus: "That the Surveys under the War Department, so far as the same are necessary for military purposes, should be continued; that all other Surveys for geographical, geological, topographical, and scientific purposes should be continued under the Department of the Interior, and that suitable appropriations should be made by Congress to accomplish these results."

There can be little doubt that though it must have chagrined some sanguine partisans whose ebullitions of temper form an amusing feature in the congressional blue-book, this decision of the Committee was in the circumstances a wise one, and one which, followed out by the Government, will have an important influence in the development of the vast and still unexplored regions over which the surveys have yet to extend. It is impossible that the corps of Engineers, weighted with all the numerous and arduous duties which form its ordinary work, should be able to furnish the necessary complement of trained geologists, botanists, naturalists, and other scientific men for the adequate exploration of the territories. In fact, the scientific work of that corps has all along been done in great measure by civilians. But it is neither needful nor desirable that civilians of high training in practical scientific work should be placed under military direction. They move more freely without it. And as in the Western Territories they declare that they no longer need the protection of an escort, the sole remaining reason for a military supervision would seem to be removed.

The Surveys of the Department of the Interior claim the first place from their voluminousness and from the wide area to which they refer. As already mentioned, they have been carried on since their beginning by Dr. F. V. Hayden, to whose skill in geological work, and tact in diplomatic relations with Government bureaux, officials, and fellow-labourers in science, their success is certainly in large measure due. For the last twenty-two years he has given himself to the exploration of the north-western territories. In the spring of 1853 he ascended the Missouri in one of the American Fur Company's steamboats and spent three years up there, during which time he accumulated considerable collections in natural history. In 1856 he joined an expedition of the Engineer Topographical Corps to that region as surgeon and naturalist. On the outbreak of the Civil War he took service in the Federal Army, as Surgeon of Volunteers, and served four years. But when the war ended, finding himself out of employment, he in 1866 returned to the north-west on his own resources, and resumed his researches in the natural history of that region. In the following year, Congress having made a small grant of $5,000 towards a Geological Survey of Nebraska, Dr. Hayden received the charge of it. This was the beginning of his career as Government geologist. But his path was not strewn with roses, either amid the hills of Nebraska or in the Government Offices at Washington. The sum appropriated for his survey in 1867 was the unexpended balance of the grant for the legislative expenses of the territory. He had a sore fight to get it renewed next year. But in 1869 Congress took up the question in a broader spirit, and sanctioned a general geological survey of the Territories of the United States, with an appropriation of $10,000 to be administered by the Department of the Interior. Since that date, owing no doubt to the marked success of the Survey, the grant has grown rapidly in amount, till at present it stands at $75,000.

This great increase in the amount of funds at his disposal has enabled Dr. Hayden to augment and equip his staff to an extent very different from that of his modest beginning in 1867. According to his last published report he organises his force into three geological parties, each completely furnished and able to act independently, so that if desired it could be transferred to any portion of the public domain. Each of these parties consists of a topographer, an assistant topographer, a geologist, two packers, a cook, and usually two or three others as general assistants or collectors in natural history. But besides these he has still three other parties, one for the purpose of carrying on the primary triangulation of the country and thus correcting and harmonising the trigonometrical work of the other or geological explorers, a second for procuring photographs and information likely to be useful to the other parties and the public, and a third, and not least important, the quartermaster's party, for furnishing supplies to all the others. These three last-named parties traverse the entire field of work.

A mere inspection of the catalogue of the publications of the Geological Survey of the Territories is enough to show what an enormous amount of work has been got through in seven years. First of all there is an Annual Report of Progress, in which, without waiting for completed surveys, the general results of each year's work are given, in geology, palæontology, mineralogy, natural history, meteorology, archæology, and economic products of every kind. Then come what are called Miscellaneous Publications and "Bulletins"—little pamphlets giving data in meteorology, topography, natural history, or other information gathered in the course of the Survey. Next we have large quarto monographs, admirably printed and illustrated, devoted to the discussion of the more technical and matured results, such, for instance, as the palæontology of a wide region or of a formation. Lastly, a series of topographical maps of parts of the districts surveyed has been published. These will be of great value as a basis for the general map to be afterwards constructed. Geologists in this country accustomed to the elaborate geological maps issued by our Government, may perhaps at first wonder why geological maps, properly so called, do not appear among the publications of the Geological Survey of the Territories. But the delay in the issuing of a general map is as necessary as it is prudent. A report may be written of what one sees. It is complete in itself; and if it is found to contain errors, these can be corrected in a subsequent report. But a sheet of a geological map must fit accurately to its neighbours. If it is surveyed and published without waiting for the investigation of the surrounding area, it will most probably be found somewhere, at least, erroneous; and to make it harmonise with adjoining sheets may require so much alteration as to demand, perhaps, even the cancelling of the old and the engraving of a new plate. Therefore we are content to wait for Dr. Hayden's geological map of the Territories in confident anticipation that it will be worthy of the high reputation which he and his staff have already gained.

It should be added, that with the most praiseworthy liberality the publications of the Survey are distributed as gifts to learned bodies and scientific men all over the world. All that is asked is that, where possible, the scientific publications of the recipients of the volumes may be sent in exchange. It is to be hoped that this generous spirit has called forth a similar feeling elsewhere, and that the library of the Geological Survey of the Territories is continually augmented by presents from all parts of the world.

— ARCH. GEIKIE

FISKE'S "COSMIC PHILOSOPHY"

Outlines of Cosmic Philosophy, based on the Doctrine of Evolution, with Criticisms on the Positive Philosophy. By John Fiske, M.A., LL.B., Assistant Librarian, and formerly Lecturer on Philosophy, at Harvard University. 2 vols. (London: Macmillan and Co., 1874.)

WE have repeatedly expressed our admiration of the system of philosophy which Mr. Spencer is engaged in working out. Mr. Fiske, in giving an outline of this philosophy, has called it *Cosmic;* a name which he thinks peculiarly fitting, because "the term 'Cosmos' *connotes* the orderly succession of phenomena quite as forcibly as it *denotes* the totality of phenomena; and with anything absolute or ontological, with anything save the 'Mundus' or orderly world of phenomena, it has nothing whatever to do." But Mr. Spencer is far from ignoring the absolute, and the ontological element in his speculations has frequently been the subject of criticism; and surely Mr. Fiske goes beyond an account of the orderly succession of phenomena in all that he has to say about the "Infinite Power manifested in the world of phenomena," which he finds that we are clearly bound to symbolise as quasi-psychical rather than as quasi-material, so that we may say with meaning, "God is Spirit, though we may not say, in the materialistic sense, that God is Force."

As the Evolution-Philosophy, which is for the most part but higher science, has swallowed up the rival systems of former times, and now stands itself without a rival, we need not pause to speak of its merits. Our first duty then is to acknowledge that Mr. Fiske has succeeded in giving a very faithful and attractive sketch of Mr. Spencer's philosophy. He has made all the thoughts his own, and has, we should think, secured for himself a recognised place among the most advanced thinkers of our time. But Mr. Fiske claims that his work shall be regarded as more than a mere reproduction of Mr. Spencer's thoughts. It contains "much new matter, both critical and constructive." In relation to the evolution of society, the author supposes he has anticipated what "will doubtless be much more thoroughly and satisfactorily presented by Mr. Spencer in his forthcoming work on Sociology." Without stopping to inquire whether a love of system may not here, as elsewhere, have led to a slight waste of energy and a straining of words, it must without doubt be recognised that Mr. Fiske has expressed with clearness and ability many large and important truths, the recognition of which must have a very healthy and elevating effect. Nothing can be better than for people to reflect that moral progress consists in the continual "adaptation of the desires of each individual to the requirements arising from the coexistent desires of all neighbouring individuals." Again, the superiority of a true philosophy over some modes of thought which still claim to be the most advanced, may be learned from Mr. Fiske's profound appreciation of the vital part played by the Roman Church in the evolution of European civilisation.

The original matter, however, on which the author lays most stress, refers to the genesis of man. He works out a theory as to the part taken by the prolongation of human infancy in originating social evolution, which, in his own words, "is entirely new in all its features." To account for the passage from mere gregariousness to sociality as marked by permanent family groups, is the problem Mr. Fiske has set himself, and his solution is this:—Mr. Wallace has given a most beautiful exposition of the operation of natural selection at that point in the evolution of man from a lower form when variations in intelligence began to be seized on and preserved rather than variations in bodily structure. It was then that our remote progenitors began to clothe their bodies and to prepare their food, that the ape of many devices survived where his perhaps stronger or swifter contemporaries perished. Now, increase in intelligence, says Mr. Fiske, implies increase in size and complexity of brain; and, as a matter of observation, this structure, as it becomes more and more complex, is less and less definitely organised at birth; then arises the phenomenon of infancy. The orang-outang, until about a month old, "lies on its back, tossing about and examining its hands and feet;" with the lowest savages the period of helplessness is much longer, and as civilisation advances, the period during which the child must depend on the parent for support, becomes still longer. Mr. Fiske believes that these considerations supply "a very thorough and satisfactory explanation of the change from gregariousness to sociality." "The prolonged helplessness of the offspring must keep the parents together for longer and longer periods in successive epochs; and when at last the association is so long kept up that the older children are growing mature, while the younger ones still need protection, the family relations begin to become permanent. The parents have lived so long in company that to seek new companionships involves some disturbance of ingrained habits; and meanwhile the older sons are more likely to continue their original association with each other than to establish associations with strangers, since they have common objects to achieve, and common enmities, bequeathed and acquired, with neighbouring families. As the parent dies, the headship of the family thus established devolves upon the oldest, or bravest, or most sagacious male remaining. Thus the little group gradually becomes a clan, the members of which are united by ties considerably stronger than those which ally them to members of adjacent clans, with whom they may indeed combine to resist the aggressions of yet further outlying clans, or of formidable beasts, but towards whom their feelings are usually those of hostile rivalry." "In this new suggestion," says Mr. Fiske, "as to the causes and the effects of the prolonged infancy of man, I believe we have a suggestion as fruitful as the one which we owe to Mr. Wallace," and "the clue to the solution of the entire problem" of the origin of the human race.

Towards the end of the second volume there is a good deal of more or less original matter relating to religion, much of which we think open to serious criticism, but on which we cannot enter here. There is, however, in the writings of Mr. Spencer, a view (adopted by Mr. Fiske) with respect to the relation of feeling to movement which appears to us to be nothing more than a popular fallacy, and which, as it seems to us, spreads much confusion through the psychological part of his system. The assumption against which we would direct some criticism is, that feelings stand in a causal relation to bodily movements. The point has recently occupied some attention, but we must reserve our remarks for another article.

Though we admire the far-reaching speculations of Mr. Spencer as more wonderfully consistent than the thoughts of any other thinker of equal range, we cannot regard his writings as criticism-proof at all points. Mr. Fiske, in arguing against the volitional theory of causation, says: "Phenomenally we know of will only as the cause of certain limited and very peculiar kinds of activity displayed by the nerves and muscles of the higher animals. And to argue from this that all other kinds of activity are equally caused by will . . . is as monstrous a stretch of assumption as can well be imagined." "Because this is the only cause of which we are conscious, . . . we are asked to assume, without further evidence, that throughout the infinitely multitudinous and heterogeneous phenomena of nature no other kind of cause exists. A more amazing example of the audacity of the subjective method could hardly be found." We hope soon to see the evolution philosophy rendered at once more consistent with itself, and able to give to the volitionist a more complete answer than is to be found in this "crushing refutation;" at which the volitionist will but smile, believing the strong language to be but a make-weight to the weak argument. The argument, as it stands, is Mr. Fiske's; it is in the admission made to the volitionist, viz. that certain movements are caused by feeling, that he follows Mr. Spencer. We contrariwise maintain that an antecedent feeling is never the cause of any movement whatever, that there is no evidence of its being so, that the phenomena of life and motion can be wholly accounted for without such assumption; that the assumption, that feeling causes movements, though it can be expressed in words, cannot be represented in thought; and that the thing asserted is inconsistent with the physical explanation of the objective side of the universe—of all physical phenomena, and movements are such—which is a fundamental idea in Mr. Spencer's philosophy. When this is accepted, the answer to the volitionist will be, that he takes for the cause of all action not that which is phenomenally known "only as the cause of certain limited and very peculiar kinds of activity," but that which is not known to be, and cannot be conceived of as, the cause of any activity.

Justice cannot be done to this criticism in a review article in these columns. We shall therefore content ourselves with calling attention to some of the confusion which, as it seems to us, this popular fallacy introduces into the philosophy Mr. Fiske expounds in these volumes. First, let us have no misunderstanding, if that be possible among philosophers. Certain states of consciousness, which precede certain bodily movements, and which are called by the learned "volitions," have in all ages been believed to be the cause of these movements. This opinion is perhaps as ancient as the human mind, more ancient than, and the father of, the earliest conceptions of deity. It is still the all but universal opinion, not of the vulgar, but of the most cultured. Quoting from Mr. J. S. Mill, Mr. Fiske says: "Our will causes our bodily actions in the same sense (and in no other) in which cold causes ice or a spark causes an explosion of gunpowder." In a passage quoted from Sir William Hamilton, also with approval, we have this definite expression: "A multitude of solid and fluid parts must be set in motion by the will."

Now let us in effect deny all this in Mr. Fiske's own words. Speaking of what he calls "the closed circuit of motion, motion, motion," he says: "No conceivable advance in physical discovery can get us out of this closed circuit, and into this circuit psychical phenomena do not enter. Psychical phenomena stand *outside* this circuit, *parallel* with that brief segment of it which is made up of molecular motions in nerve-tissue." "However strict the parallelism may be, within the limits of our experience, between the phenomena of mind and this segment of the circuit of motions, the task of transcending or abolishing the radical antithesis between the phenomena of mind and the phenomena of motions of matter must always remain an impracticable task. For in order to transcend or abolish this radical antithesis we must be prepared to show how a given quantity of molecular motion in nerve-tissue can become transformed into a definable amount of ideation or feeling." Strange that it does not occur to our philosophers that they just leap this impassable gulf from the other side when they talk about a multitude of solid and fluid parts being set in motion by the will, in the same sense in which a spark causes an explosion of gunpowder. Either the volition is itself a mode of motion, which Mr. Fiske solemnly denies, or the circuit is not closed, which he as solemnly asserts it to be.

The inconsistency and consequent error, to which we have called attention, cause much more widespread confusion than might at first be supposed. In one direction we have seen the closed circuit of motion broken in on. In the opposite direction we have elaborate attempts to evolve mind out of matter, all specific and impressive declarations to the contrary notwithstanding. In this direction Mr. Lewes has gone forward with a more uncompromising logic than is to be found in the volumes before us. Mr. Fiske agrees with Mr. Lewes that both "life and mind are processes," but we do not find that he goes on to picture consciousness "as a mass of stationary waves formed out of the individual waves of neural tremors." The evolution philosophy, starting from the primeval nebula, finds every science a specialised part of some more general science. Biology is a specialised part of geology, and psychology is a specialised part of biology. "Mind here appears," says Mr. Fiske, "to be but the highest form of Life," and life, as admirably defined by Mr. Spencer, "is the definite combination of heterogeneous changes, both simultaneous and successive, in correspondence with external co-existences and sequences." Truly the study of the higher forms of these phenomena may be called a specialised part of biology. But may we call any adjustment of internal relations to external relations *Mind?* We think not, and in this Mr. Fiske heartily agrees with us, for he hastens to tell us that "push our researches in biology as far as we may, the most we can ever ascertain is that certain nerve-changes succeed certain other nerve-changes or certain external stimuli in a certain definite order. But all this of itself can render no account of the simplest phenomenon of consciousness." And Mr. Spencer is equally emphatic:—"The thoughts and feeling which constitute a consciousness form an existence that has no place among the existences with which the rest of the sciences deal." But where are we now? If in psychology any part of the phenomena studied are those given directly in consciousness, then they are not the phenomena which form a specialised part of biology. Consciousness, then, is not evolved out of the primeval nebula. It creeps in surreptiously somewhere in the course of the evolution of organised beings, and appears in man, the highest product of evolution, as a power guiding his movements. This, to our mind, is the weak point in Mr. Spencer's philosophy.

Let us glance at Mr. Fiske's chapter on the Evolution of Mind, which he tells us "was mostly written, and the theory contained therein entirely worked out, before the publication of Part V. of the second edition of Mr. Spencer's 'Principles of Psychology.'" In so far as this so-called theory of the evolution of mind is an account of the evolution of the nervous system, it may be open to no serious criticism. But what happens is this: From talking of waves of molecular disturbance passing along finished channels and finding for themselves new courses in lines of least resistance, the language gradually changes; a process entirely physical, "reflex action, which is unaccompanied by consciousness," is called "the simplest form of psychical life." Instinct is found to be compound reflex action. And in the higher organisms "there will be a number of permanent transit-lines and a number of such lines in process of formation, along with a continual tendency towards the establishment of new ones. The consequences of this are obvious. In becoming more and more complex, the correspondence becomes less and less instantaneous and decided. 'They gradually lose their distinctly automatic character, and that which we call instinct merges into something higher.'" What is the something higher into which all these nervous operations merge? Into mind as we see it in man, who is supposed to perform actions "with the assistance of reason, volition, and conscious memory."

It is, however, when specially engaged with the consideration of voluntary action that the confusion may be said to reach a climax. But Mr. Fiske has no misgiving; he proceeds, confident that he has clear ideas to expound, and that he is expounding them in clear and consistent language. "Volition," he tells us, "is that transformation of feeling into action which is attended by a conscious comparison of impressions." If *feeling* may be transformed into *action*, why may not motion be transformed into feeling? Having written this he cannot well afford to sneer at the materialist. Though mind and motion, as we are often told, have no kinship, yet here are a few sentences which are perhaps expected to help us towards a mental picture of the curious "dynamic process" "whereby feeling initiates action."—"In a complex aggregate, like the human or animal organism, such a state of equilibrium (as the ass between the two bundles of hay) cannot be of long continuance. Sooner or later—either from the greater vividness with which one of the desired objects is mentally realised, or from any one of a thousand other disturbing circumstances down to those of a purely physical nature—one desire will become stronger than the other, and instantly thereupon, the surplus nervous tension remaining after the weaker desire is neutralised, will pass into nervous *vis viva*, or, in other words, volition will take place." It will be almost a sufficient criticism of these statements to place alongside of them a sentence from Mr. Fiske's next paragraph. "To say explicitly that volition does not follow the strongest motive, is to say implicitly that motion does not always follow the line of least resistance; which is to deny the persistence of force." With this last statement we agree; but how is it to be reconciled with the preceding sentences? Can mental vividness, or anything else not purely physical, either help or hinder motion in following the line of least resistance? To say so is to deny the persistence of force.

Having found that philosophers are very like other people, that they are sometimes almost as anxious to be thought infallible as to have any inconsistency in their writings pointed out (Mr. J. S. Mill was a grand exception), it may perhaps be as well to say that in bringing together a few passages which seem to us after careful consideration to be hopelessly inconsistent, we have been inspired by no other feeling than a desire to see the philosophy we admire purified from an error that greatly mars its beauty. Let it be accepted that states of consciousness really stand outside the circuit of motions and therefore can never be a cause of any movement, and the occasion of all the confusion of which we have spoken disappears.

Mr. Spencer, who has been so kind as to read the proof of this article, tells me by letter that he thinks I have not quite remembered his point of view and its implications. He says :—" The implication of your argument seems to be that I identify motion as it actually exists with motion as manifested to our consciousness. Did I do this there would be the inconsistency you allege in the supposition that feeling is transformable into motion and motion into feeling. . . . But that transformation which I assume to take place (though without in the least understanding how) is the transformation of the subjective activity we call feeling (unknowable in its ultimate nature) into the objective activity we call motion (also unknowable in its ultimate nature)." On the metaphysical question my own view probably does not differ much from Mr. Spencer's ; but I would have it kept distinct from the question of ordinary science, which deals only with the relations of things as manifested to our consciousness. And I leave it to Mr. Fiske and his readers to determine whether in the passages I have quoted from his work he means motion and feeling as known to us—the motion and feeling of science, or the ontological entities of the metaphysician, with which in his preface he has told us his system "has nothing whatever to do." DOUGLAS A. SPALDING

OUR BOOK SHELF

Notes on the Fertilisation of the Cereals. By A. S. Wilson. (Reprinted from the "Transactions of the Botanical Society of Edinburgh.")

NOTWITHSTANDING the practical importance to the farmer of a knowledge of the mode in which our cereal crops are fertilised, it is singular that different views still prevail on several essential particulars. One point appears to be generally conceded, that insects have nothing to do with it ; the ovules are either self-fertilised, or cross-fertilised by the agency of the wind. Dr. Boswell-Syme and the present author incline towards the former ; Delpino and Hildebrand to the latter view, at all events in the case of wheat ; and Belgian farmers still trail ropes over their flowering wheat to insure complete fertilisation. Although we cannot altogether agree with Mr. Wilson's conclusions, he has added some most valuable observations to our knowledge of the subject, especially with regard to the remarkable extension of the filaments immediately previous to, or concurrently with, the discharge of the pollen. If a rye-flower, he states, is opened a moment before the natural time of flowering, the filaments will be found to measure about one-sixteenth of an inch in length. In the course of five minutes, or less, from the instant the pales begin to open, the filaments will, in many cases, have grown to twelve-sixteenths, and the whole of the pollen will have fallen out ; and this rapid extension is not a mere straightening out of a doubled-up thread, but an actual growth. In oats and barley a similar extension takes place ; in the latter case the filaments may be seen, under an ordinary pocket lens, to be visibly growing at the rate of six inches an hour. The result at which Mr. Wilson arrives is, that the "European cereals are self-fertilised, and that the act of fertilisation, in those cases in which the flower opens, is probably performed in the opening, and is necessarily confined to the twenty or thirty minutes during which the flower remains open." We must confess that we are not convinced of the validity of the train of reasoning which led the author to this conclusion. The remarkable phenomenon of the extension of the filaments would appear to be quite useless for this purpose, Mr. Wilson's drawing showing that its effect is to remove the anthers from the immediate proximity of the stigmas to a considerable distance from them. The whole mechanism of the "versatile" anthers, lightly suspended at the end of very slender filaments, the immense quantity of light dry pollen, and the sudden jerk by which the flowers are opened, appear to lead *primâ facie* to an opposite conclusion, and to suggest the agency of the wind. On two other points Mr. Wilson seems to us to have been led into some confusion by an incorrect use of terms. He speaks of the meaning of the word "fertilisation" as being "partly a matter of convention ; it may mean that act of the anthers by which they project or discharge the pollen, which, falling directly on the pistil, shall produce the embryo ; or it may mean the falling of the pollen on the ovule after being carried a distance by the wind ; or it may apply to the instant in which the elements of the pollen set up that action in the ovule which produces a new plant ;" and he employs the word throughout in the first of these meanings. Now we believe that all our best writers use the term as synonymous with "impregnation" or "fecundation ;" and that the correct expression for the falling of the pollen on the stigma—the German "Bestäubung"—is "pollination"; Mr. Wilson's "fertilisation" being simply the discharge of the pollen from the anther, which may or may not "pollinate" the stigma and "fertilise" the ovules. He also finds fault with those botanists who distinguish between "cross-fertilisation" and "self-fertilisation"—the fertilisation of ovules by pollen from a different or from the same flower—without being able to define accurately the physiological difference between the two processes. The terms are, however, currently used, and we think quite correctly, to express an actual external difference, which we know from experience to be frequently accompanied by results of a different character ; even though we are not at present able to trace this difference to its physiological causes. Notwithstanding these points, to which we have felt bound to call attention, the present treatise is one of the most important contributions yet made to our knowledge of the remarkable phenomena connected with fertilisation.

A. W. B.

Official Guide to the Kew Museums ; a Handbook to the Museums of Economic Botany of the Royal Gardens, Kew. By Daniel Oliver, F.R.S. Sixth edition, with additions by J. R. Jackson, A.L.S., Curator of the Museums. (J. R. Jackson, Museum, Kew. 8vo., 92 pages.)

ALTHOUGH this is by no means a complete catalogue or guide to all the objects exhibited in the museums at Kew, very few substances of commercial importance have been overlooked. Necessarily in so small a book, little is said of the relative value, &c., of different fibres and other vegetable substances ; but it will be found useful to all interested in applied botany, inasmuch as it embodies all recent discoveries of interest to the druggist, manufacturer, or artist. The products are arranged in families according to their affinities, and by means of this guide, which has a complete index of trivial and technical names, the visitor can readily find any article of which he may be in search. One thing, however, is certain, the Government might, by a small grant in aid of a more comprehensive publication, render the fine collection of vegetable products at Kew of infinitely more service to the general public.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

On the Mechanical Work done in exhausting a Muscle

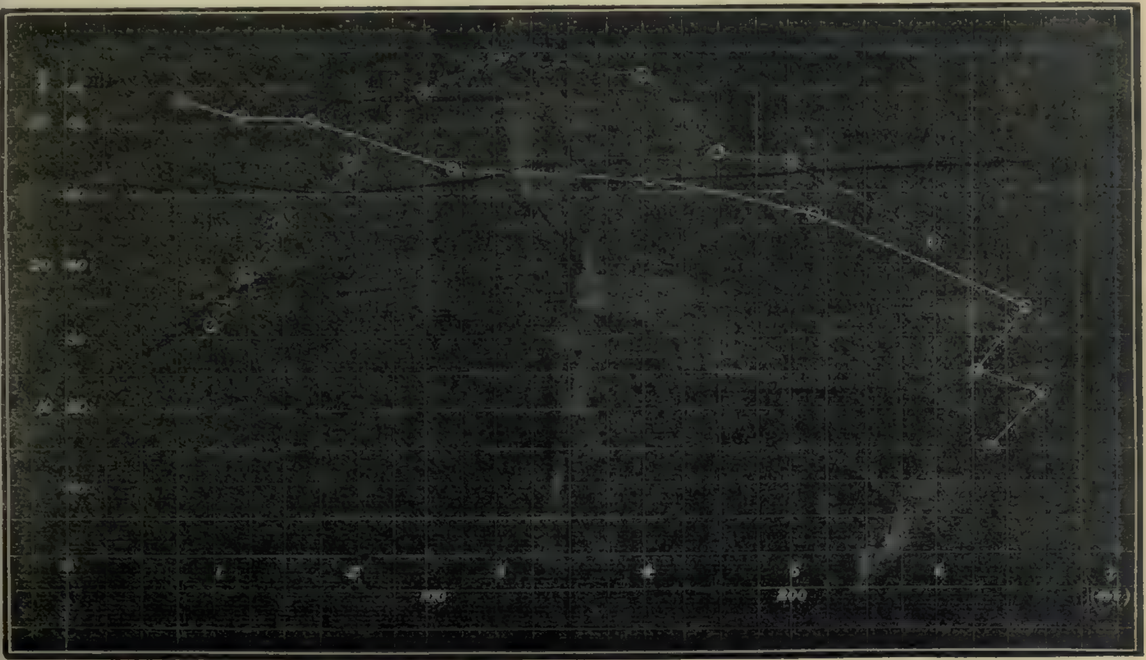
I BEG leave to make some reply to the comments (NATURE, vol. xi. pp. 464, 488) of Prof. Haughton on my paper.

1. In regard to the relative value of my earlier and later experiments, it is to be said, that in one sense they are all equally valuable. My object, however, was to find the work of exhaustion when the intervals of work and rest were equal, the work to be expended only in lifting the weight. Hence the experiments were made in such a way as to eliminate the fatigue caused by the falling weight. Prof. Preston and myself practised for several weeks, until we were able to keep accurate time, before the published series was begun. All who saw the experiments were then satisfied that the later method of experiment was an improvement. The two series first published were made with equal care, and I am therefore at some loss to know what has been Prof. Haughton's criterion in deciding that one was good and the other bad.

2. In dealing with Prof. Haughton's equation—

$$n = \frac{A.t}{1 + \beta t^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

when it was said that the co-ordinated values of $\frac{n}{t}$ and $n{\cdot}t$ formed a curve, the meaning could only have been that β is not a constant. Prof. Haughton is of course right in saying that the observations thus co-ordinated "may be represented by a straight line." He might also have added that for properly chosen limits, any other observations may also be represented by a straight line. The point is, whether these lines give any evidence of regular deviations. It seems to me that "any one accustomed to such observations" ought to be able to see such evidence in the diagrams of Prof. Haughton in NATURE, *loc. cit.* In this connection I wish to give a series of experiments, the time of lift t being variable and equal to the interval of rest. The values of n are the means of four experiments, and are uncorrected for variations in strength. The experiments were made with the apparatus described in my last paper (NATURE, vol. xi. pp. 256, 276) and my right arm.



Raising weight of 4·5 *kgr. through* 0·70 *in* t *sec.*

t	n	$\frac{n}{t}$	$n{\cdot}t$
1·00	31·7	31·7	31·7
1·25	38·7	30·6	48·4
1·50	45·5	30·3	68·3
2·00	54·0	27·0	108·0
2·50	64·7	25·9	161·8
3·00	69·2	23·1	207·6
4·00	66·5	16·6	266·0
4·50	56·0	12·4	252·0
5·00	54·0	10·8	270·0
6·00	42·5	7·1	255·0

The values of n and t are represented in the diagram by the dotted line. It will be seen that n reaches a maximum where $t = 3{\cdot}4$.

The values of $\left(\frac{n}{t}\right)$ and $(n{\cdot}t)$ are also represented by the full line. It will be observed that the observations on opposite sides of the maximum n are not continuous. A comparison of this line with those given by Prof. Haughton in NATURE, vol. xi. p. 465, will be found instructive.

3. In the case just considered, the time of exhaustion depends upon the velocity of disintegration and recuperation of the muscles. It is well known that the velocities of such operations, taking place in time, are represented by the binomial curve. I have satisfied myself that the values of n in the above series are represented by the terms of the expanded binomial $(p + q)^m$ where $p + q = 1$; where p and q are unequal, and where $m = 1$ represents the total number of chances. This point is reserved for future investigation.

4. In my paper in the *American Journal of Science* (Feb. 1875, pp. 130–137), the accuracy with which Prof. Haughton's formula represents my experiments, was shown. Assuming

$$(w + a)\,hn = \frac{A}{(w + a)^v}$$

where a is the reduced weight of the arm, and Prof. Haughton's law demands that v = unity. It turns out to be 2·6. Prof.

Haughton refers the difficulty to my experiments, and I refer the difficulty to his theory.

5. Prof. Haughton objects to my reduction for variations in strength. In reply, it is to be said that an increase of from 13·66 kgr. to 14·84 kgr. in the strength of Mr. Myer's arm, caused *n* to vary from 78 to 1366. The weight used was 5·00 kgr. For a weight of one or two kgr. my own arm also varies thus greatly. I therefore conclude that this reduction is not only not improper, but that it is essential.

6. I beg leave to state that I alone am responsible for the paper published in NATURE, vol. xi, pp. 256–276. I acknowledged therein all the aid that I am conscious of having received. F. E. NIPHER

Washington University, St. Louis

P.S.—I find that one important point in Prof. Haughton's paper has been overlooked in my reply. Objection is made to my last series of experiments, on the ground that all the muscles thrown into action are not exhausted. If this objection is well taken, it applies also to the former series of mine, so "highly confirmatory of the Law of Fatigue," the agreement of which with Prof. Haughton's formula is so "complete and satisfactory." The *lifting* of the weight was done in precisely the same way.

Domestic Economy of Blackbirds

TWO Blackbirds having built their nest in full view of my bedroom window, I have been much interested in watching the process of feeding their young, &c. The cock bird is the principal forager, and the food generally brought are worms. My object in writing is to draw attention to one feature which may be unknown to most of your readers as relates to the disposal of the young birds' droppings. If left in the nest, it would become filthy, if thrown aside the accumulation would lead to detection, and I believe the general impression is that the old birds carry the soil away; but on watching them closely I never saw the droppings carried away but on one occasion, and that by the hen; in every other instance after being fed, the young birds in turn lift up their tails and the droppings are taken by the old bird and actually swallowed. On the 15th July the young birds being fully fledged, were literally washed out of their nest by the downpour of rain on that day, but, with a little care, they all survived. On the 22nd the hen again returned to her nest, and she is now sitting closely on three eggs, and I hope to get the next brood photographed. I enclose my card and address, and should any readers of NATURE desire to witness what I have described, I shall be very glad to afford them an opportunity.

Woolwich Common, 2nd Aug., 1875 E. R. W.

Scarcity of Birds

MR. BARRINGTON, writing from the Co. Wicklow, in NATURE, vol. xii. p. 213, says that he finds Blackbirds and Thrushes unusually scarce this year. I have not heard of this anywhere else, and certainly it is not the case here.

Old Forge, Dunmurry, JOSEPH JOHN MURPHY
Co. Antrim, July 26

Hay Crops of 1875

LET me record in NATURE the extraordinary fact that on Monday, July 26, in one of my meadows here, the first crop was carried while the second crop, or after-math, was being cut.

Valentines, Ilford C. M. INGLEBY

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—The last number of *Vierteljahrsschrift der Astronomischen Gesellschaft* (x. Jahrgang, weites Heft), received within a few days, contains an ephemeris of most of the known variables, including those of short period, for the year 1876, drawn up by Dr. Schœnfeld, chiefly from the data in his catalogue of 1875. This early publication will, no doubt, be very acceptable to observers who are devoting attention to these interesting and puzzling objects.

THE GREAT CLUSTER, MESSIER 11.—As the first special publication of the Observatory of Hamburg, we have Prof. Helmert's memoir detailing the results of his micrometrical observations on the components of this well-known cluster in the constellation Aquila, or in *Clypeum* or *Scutum Sobieski*, as many of the Continental astronomers continue to call that part of the heavens in which it is situate. The memoir has a particular interest from the circumstance of Dr. Lamont having similarly employed the Munich refractor in the years 1836-39. The investigation of any changes that may take place in the constituents of these groups of stars, as regards position or brightness, becomes a very attractive one, and as we know from the excellent work of Herr Pihl on the Perseus cluster, it is not one always requiring the use of large instruments, such as have been employed in the hands of Lamont and Helmert, upon Messier 11. D'Arrest terms this cluster "magnifica innumerabilium stellarum coacervatio"; the amateur will remember Admiral Smyth's comparison of the configuration of the components to "a flight of wild ducks."

NEW MINOR PLANET.—No. 147 of this group was detected by Herr Schulhof, at the observatory of Vienna, on July 10, in the vicinity of β Capricorni. It is of the twelfth magnitude, and Prof. Littröw, the director, proposes to call it "Protogeneia," perhaps in allusion to it being the first minor planet discovered at this observatory. It may be presumed that he has satisfied himself of its distinctness from any of the minors which are now adrift.

THE GREAT COMET OF 1843.—The elements of the orbit of this remarkable body, finally derived by the late Prof. Hubbard, of the Naval Observatory, Washington, after a very masterly discussion of the whole series of observations, are as follow:—

Perihelion Passage 1843 February	27·41051	G.M.T.
Longitude of Perihelion ...	278° 40′ 17″	M. Eq. 1843.
„ Ascending Node	1 14 55	
Inclination of Orbit	35 40 39	
Excentricity	0·999915717	
Perihelion Distance	0·0055383	

Motion—retrograde.

From which we have the following additional figures:—

Mean Distance from the Sun ...	65·711	
Aphelion Distance	131·42	
Period of Revolution	532·7	years.

The distance from the sun at the perihelion is less than that of any other comet so far computed; the famous comet of 1680, according to Encke's definitive calculations, making also a very close approach, though not so near as in the present case. If Leverrier's semi-diameter of the sun be adopted, with 8″·875 for the solar parallax, we find—

Sun's semi-diameter	428,710 English miles.
Comet's perihelion distance ...	510,140 „

Whence it would appear that a little before 10 P.M. on February 27, the comet passed within 81,500 miles from the sun's surface, and if we compute the orbital velocity at the time, we find it 348·5 miles per second. The comet was less than 2¼ hours on the north side of the ecliptic, passing from ascending to descending node in 2h. 13·4m.

On examining with the above elements the track of the comet on the day of perihelion passage, it results that a transit over the sun's disc must have taken place at the descending node, the ingress (geocentric) occurring at 11h. 28m. Greenwich time, 241° from the sun's N. point towards E., and the egress at 12h. 29m., at 187° similarly reckoned. The transit might have been observed in Australia; the times for Sydney being, Feb. 27, 21h. 33m. for ingress and 22h. 34m. for egress. Such a transit brings to recollection an observation recorded in the Paris Astronomical Bulletin at the time as having been made by M. Aristide Coumbary at the observatory of Constantinople, on the morning of the 8th of May, 1865, from which it would appear that a dark spot moved over a space of 21′ upon the sun's disc, in a little over three-quarters of an hour. From the data published by Coumbary we might infer on the hypothesis of circular motion, that the body, whatever its nature, had moved at a distance of about 415,000 miles from the sun's surface, and as we know from the experience afforded by the great comet of 1843, there is nothing improbable in a comet having so passed. Perhaps when the sun's disc is more systematically and widely watched, a comet may be caught in transit and properly observed. The case of the comet of 1819 is not a satisfactory one, Pastorff's observation at least attributing to it a position upon the sun's disc which it could not have occupied at the time he assigns to his observation.

COMET 1874 (II).—The comet detected by M. Coggia at Marseilles on April 17, 1874, which presented so fine an appearance in our northern heavens in July, was observed at Melbourne, and by Mr. Tebbutt, near Sydney, until the end of the first week in October. Comparing the Melbourne observation on the 6th of this month with the place given by the elliptic elements of Prof. Tietjen, the difference is found to be less than a minute of arc, and the European observations to the middle of July are very accurately represented by these elements. Between April 17th and October 6th the comet traversed an arc of 205° of true anomaly, and the near agreement of Prof. Tietjen's orbit throughout, shows that the comet when it attracted so much attention was really moving in an ellipse of very long period, though no doubt this element may be considerably varied without largely increasing the differences between calculation and observation. The period of revolution in Tietjen's ellipse is nearly 9,000 years. When a similar complete investigation has been made for this comet to that so skilfully performed by Dr. von Asten in the case of Donati's great comet of 1858, some kind of limits may be assigned to the time of revolution, but in all probability it must extend to some thousands of years. We remark that the Melbourne observations of Coggia's comet were made with a telescope of only 4½ inches aperture; no doubt the comet might have been followed some time longer with larger instruments, but it is possible that the Melbourne reflector may have been under preparation for the transit of Venus, and not conveniently available for cometary observations.

PROF. LOOMIS ON THE U.S. WEATHER MAPS *

THIS paper is in continuation of a similar paper published in July last year, in which the American Weather Maps for 1872-73 were discussed. The results then arrived at are compared with the observations of 1874, and the whole is thereafter combined into a three years' average.

The principal conclusions from the three years' observations are these:—

The mean direction of the onward course of storms is N. 81° E., or a little to the north of east, being most southerly in July (E. 7° S.), and most northerly in April and October (N. 72° E. and N. 74° E.). The mean velocity is 26 miles per hour—the maximum monthly velocity, 32 miles, being in February, and the minimum 18·4 miles in August. As regards particular storms, wide deviations from these figures take place, it being found that the actual motion of the storm's centre may have a path in any direction whatever, and the velocity of progress may vary from 15 miles per hour towards the west, to 60 miles per hour towards the east. From the tri-daily observations it is found that the average velocity of storms from 4·35 P.M. to 11 P.M. is about 25 per cent. greater than for the rest of the day, and that while this varies in different months from 14 to 32 per cent., the most rapid progress occurs in every month during this portion of the day. Prof. Loomis suggests that as this is the time of the day when the temperature is falling most rapidly, the fall of rain may be thereby accelerated, and the velocity of the storms' progress be increased by the more rapid extension of the rain-area which would follow. The meteorological system of the States fortunately furnishes the required data for the examination of this important point, and we shall look forward with great interest to discussions of the daily rainfall of the States in this connection.

It would appear that an unusual extension of the rain-area of a storm is generally accompanied by a velocity of progress greater than the mean. The average extent of the rain-area eastward from the centre of the storm is 542 miles; but when the eastern extent of this area is 100 miles greater than the mean, the hourly velocity of the storm's progress is increased 13¾ miles; and when on the other hand, the eastern extent of the rain-area is 100 miles less than the mean, the hourly velocity of progress is diminished 9½ miles. Whilst the extent of the rain-area exercises an important influence on the storm's progress, the inclination of its axis would also appear to influence to some extent the course of the storm. Professor Loomis is of opinion that the direction and velocity of the storm's progress may be predicted with some confidence, in cases when the precise limits of the rain-area are known. It is thus most desirable that rain observations form an integrant part of all weather telegrams.

The influence of areas of high barometer on the velocity and direction of a storm's course is important in connection with the prediction and theory of storms, but further observations are required for its elucidation, among the more important of which are the movements of the upper currents of the atmosphere as disclosed by observations of the cirrus cloud.

The reports of General Myer, Chief Signal Officer, for 1872-73-74 show by the barometric results for Denver and the other elevated stations on the spurs of the Rocky Mountains, that the relative distribution of atmospheric pressure at these great heights is just the reverse in summer and winter of what obtains at lower levels to eastward in these respective seasons. The point is a vitally important one in its bearings on the weather and meteorology of the States. In connection with it, we have examined with much interest the tables at pp. 10 and 11 which give the number of times during 1873 and 1874 on which the daily change of temperature amounted at the different stations to 40° and upwards. This large temperature fluctuation occurs most frequently at Colorado Springs, Denver, and the other high stations in the west. The most remarkable of these changes occured at Denver on the 14th of January 1875, at which place the temperature was below zero all day, and the wind N.E. At 9 P.M., the temperature was 1°.0 and the wind suddenly shifted to S.W.; at 9.15 P.M., the temperature had risen to 20°.0 at 9.20 P.M. to 27°.0; at 9.30 P.M., to 36°.0; and at 9.35 P.M., to 40°.0, after which there was little change till the following morning. At 11.30 A.M. of the 15th, the temperature was 52°.0 and at this time the wind suddenly backed to N.E.; at 12.30 P.M., the temperature had fallen to 4°.0 Thus in the evening of the 14th, the temperature rose 39°.0 at Denver in the short space of 35 minutes, and about noon of the following day fell 48°.0 in one hour.

ON THE HORIZONTAL PHOTOGRAPHIC TELESCOPE OF LONG FOCUS *

IN what I have now to say in regard to the methods of Photography employed in observing the recent Transit of Venus, I shall confine myself to the subject of

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* Results derived from an examination of the United States Weather Maps for 1872-73-74. By Prof. Elias Loomis, Yale College. From the *American Journal of Science and Arts*, vol. x., July 1875.

* This paper was read by the late Prof. Wenlock to a private scientific Club in Cambridge, U.S., shortly before his death; it has been forwarded to us for publication, at the request of the Club, by Prof. Asa Gray.

the instruments used, having especially in view the explanation of the advantages of the horizontal telescope and its origin.

I should not have thought it worth while to make any communication on this subject, but since it has been a matter of discussion in the French Academy, and several pamphlets have been written on the subject, it may not be uninteresting to explain here the connection of the Observatory of Harvard College with it.

In the spring of 1869, when it became necessary to begin preparations for observations of the Solar Eclipse of August 7th of that year, my attention was called especially to the subject of Solar Photography for the first time. Mr. Warren De La Rue in England, and Mr. Rutherford in America, had devoted themselves almost exclusively to astronomical photography for many years, and they were the authorities on this subject. The methods employed by them were substantially the same; each used an equatorial telescope with clock movement, and enlarged the image formed by the object-glass by means of another system of lenses, and photographed this magnified image. Mr. De La Rue corrected his object-glass to secure as nearly as possible the foci of chemical and visual rays, and Mr. Rutherford corrected his so as to obtain the best echromatic combination of the chemical rays without regard to the visual focus.

Mr. De La Rue first undertook a series of daily photographs of the sun at Kew some time previous to 1860. In making my own preparations for the Solar Eclipse of 1869, I collected what information I could about the extent and brightness of the corona, and the nature of Mr. De La Rue's photoheliograph which he employed in observing the total eclipse of 1860 in Spain. In the first part of the volume of the "Philosophical Transactions" for 1869, I found a paper which was read May 31, 1868, which contains the results of the first attempt to measure the heliographical positions and areas of sun-spots observed with the Kew photoheliograph. From the examinations of the measurements in this paper I became convinced that no trustworthy measures of photographs taken in this way could be made. The magnified image is so much distorted by the eyepiece, or the equivalent system of lenses used to form the image in the camera, that no satisfactory scale could be obtained; in fact the scale was found to vary irregularly from the centre to the circumference of the image; and even if this irregular scale could be investigated, a slight displacement of the centre of the picture from the axis of the telescope would introduce confusion. Mr. De La Rue's method of investigation consisted in photographing the pinnacle of a pagoda which was composed of rings and chains of known dimensions, and then attempting to find the scales of the different parts of the pictures from the images of this pinnacle.

The result, as I have said, satisfied me that this was a method to be avoided. The difficulty arising from the distortion of the image, and the apprehension that the light of the corona might be so enfeebled by enlargement that it would not make an impression on the plate, determined me to photograph the image in the principal focus of the object-glass.

All of the many other parties fitted out for photographing the total phase of this eclipse followed the method of De la Rue and Rutherford; the expedition from the Observatory of Harvard College was the only one that succeeded in getting a picture of the corona. The method of De la Rue was employed in the preceding eclipse of 1868, and no photograph of the corona was secured. I mention these facts simply to show how little the disadvantages of enlarging the image by an eye-piece were appreciated. In the next eclipse no party went into the field with De la Rue's plan; every one of them photographed in the principal focus, but this time, on account of the weather, the American party in Spain alone succeeded in getting the corona.

In 1871, in India, this method was again followed by all the parties, and was successful. My preparatory experiments in 1869 were made with an equatorial of 7 feet focal length, which gave an image of about three-fourths of an inch, and with the great equatorial of 24 feet, which gave an image of 2½ inches diameter.

Measurements of photographs of the smaller image seemed to indicate that under a microscope an accuracy comparable with that of the best meridian circles was attainable; but believing that a larger image would be better, I thought that four inches would be a convenient size. In order to get such an image free from the distortion of the eye-piece, I must have a telescope 40 feet in length. Immediately on my return from the eclipse of 1869, I ordered a lens of Messrs. Clark and Sons, of 40 feet focus, and a micrometer capable of measuring conveniently an image of four inches diameter. Thus the long telescope was adopted to escape the distortion.

Then of course the difficulty of mounting and handling a telescope of this length, especially when extreme precision in measuring was the main object, naturally presented itself. To obviate this I resorted to the very simple expedient of placing the telescope horizontally, so that it need not be moved at all, and reflecting the light of the sun through it by means of a plane mirror. This seemed likely to meet all of the difficulties of the case; the well-known methods of mounting and directing collimators rendered the utmost degree of accuracy attainable in directing such a telescope, and by putting the object-glass on one pier and the camera on another, using a tube which should touch neither, only for excluding the light, all disturbance of the focus by the expansion of the long tube was avoided.

Other information obtained by my preparatory experiments had an important bearing upon my plan at this time. I had found how difficult it was to get an exposure of the plate short enough. It became necessary to reduce the apertures of the equatorials to one or two inches, and then throw the slide across with a strong spring. From this I derived two important suggestions: one, that a heliostat driven by clockwork was not indispensable, as the picture would be instantaneous, so that the motion of the sun during the exposure would be of no consequence. The other was that I might reduce the light by using a transparent glass reflector, and not be compelled to reduce the aperture of the telescope so much. By these means the cost of the experiment was greatly reduced, saving the expense both of a heliostat and of a silvered mirror. Messrs. Clark and Sons did not get the apparatus ready for use at the Observatory until July 1870, although it was tried at their shop previously. A series of daily photographs was begun with it, July 4, 1870, and has been kept up with little interruption to the present time.

At this time and for a year or two after, I had not heard of this method being thought of by any one. No one of my acquaintances seemed to have any knowledge of any other claimant of the method. Mr. Rutherford, with whom I had frequent communication, and who had been occupied with the subject for twenty years, regarded it as new and original. It was described in Mr. Lockyer's paper in 1870, and attributed to me; Mr. Newcomb, in the latter part of 1872, speaks of it as a method devised by me, and in successful operation for several years, and also independently proposed by Faye. Lord Lindsay adopted it for his expedition to the Mauritius. Mr. De La Rue in several communications down to 1873 spoke of it as the method of the American Astronomers. It was afterwards, about this time, called the method invented by Foucault and Prof. Winlock independently. Then, in 1873, I received a book by M. Edmond Dubois, claiming it as a French invention, and giving the whole credit to Capt. Laussedat, closing with the remark that if it should be successful the glory would belong to France. Afterwards I received a pamphlet of twenty-six pages, by Capt. Laussedat, in which, ignoring me entirely, he tried to sustain his claims against those of Faye, Foucault, and Fizeau.

In 1873, after the horizontal telescope had been in successful operation for three years, after specimens, both negatives and lithographic copies had been distributed in Europe, the French Commission, which had up to this time been making their preparations to use the method of de La Rue, adopted the horizontal telescope. It would appear from this, that whatever might have been done or said on this subject by the Frenchmen named above, it had not contributed much to a clear appreciation of the advantages of the method until after they had been demonstrated here.

Without caring anything about credit for priority of suggestion in such matters, being satisfied that no similar instrument was in use or had been used before the one at Harvard College, I was yet interested enough in the matter to look up the claims put forth by these gentlemen, and to see why they happened to be overlooked for so long a time, even by their own countrymen. I find that credit is accorded to Foucault, mainly for his perfection of the heliostat, both for the plane mirror and for the uniform motion. He published nothing in regard to its application to photography. After his death his friend, St. Claire Deville, spoke of it as one of the things that Foucault intended to do. He at the same time contemplated the use of the siderostat in all kinds of astronomical observations. M. Laussedat is unwilling to give him any share of credit for the horizontal telescope. M. Faye gives him credit only for the heliostat.

M. Faye himself took some photographs of the sun with a very long telescope of one M. Porro, of 15 meters focal length. The telescope was pointed directly at the sun. M. Faye's remarks on them before the Academy related only to the advantage of their size and their distinctness. He had nothing to say about the peculiar advantages of the long telescope, but he anticipated all succeeding inventions in the application of Photography to astronomy by predicting its early use in meridian and every other class of observations.

His next communication on this subject was on March 14, 1870, on the occasion of presenting a letter from M. Laussedat on the subject of a horizontal telescope. This was six months after my apparatus was ordered, and after some experiments had been made with it. In this communication he appears at first glance to have suggested the whole arrangement now adopted; but on closer examination he does not seem to have had any clear ideas about it. He recommends the use of a long telescope because he had seen good pictures with a long telescope; he nowhere speaks of his reasons for dispensing with the eyepiece, and in fact it does not clearly appear that he did dispense with it. In September, 1872, after it had been in use for two years and several accounts of it had been published, in his comments before the Academy on a paper of Warren De la Rue's, he seems to have understood for the first time the true theory of the long horizontal telescope.

Capt. Laussedat appears to have the most substantial claim of any that have been mentioned thus far. He used a horizontal telescope in Algeria in 1860, in observing the total eclipse of that year; but he used a very short telescope and had an eyepiece to enlarge and distort the image. His own account of what led him to this method was that he had no equatorial mounting for his little telescope and that no means were furnished him to buy one, but he had a good heliostat, and he resorted to the method as a makeshift. He fully appreciated, however, the advantages over the other method in the accuracy of orientation and in the certainty with which fixed lines of reference could be had on the plates.

M. Faye, in his communication of Sept. 1872, seriously claims that his use of the long telescope pointed to the sun in 1858—because M. Porro happened to have one, and Capt. Laussedat's use of a short one, placed horizontal, because he had no equatorial stand and clock movement—together make up the invention of the telescope as it is now used.

But, after all that has been said about the priority of suggestion, that question is settled finally by some one * in England finding that the wole arrangement was suggested by Hooke in 1676. A late communication on the subject in the *New York Times* calls it a method suggested by Hooke and perfected by Foucault.

In Hooke's day they had none but very long telescopes, but they had no heliostats. No practical application of his suggestion, however, seems to have been made.

ON THE CARDIOGRAPH TRACE

BY placing the sphygmograph, as constructed by M. Marey, over that portion of the chest where the heart can be best felt beating, instead of on the wrist-pulse for which the instrument is constructed, tracings called cardiograms can be obtained which bring to light physiological facts not otherwise ascertainable. In the last-published volume of the Guy's Hospital Reports there is a paper by Dr. Galabin, on the interpretation of these tracings, which will be read with interest by physiologists on account of the considerable difficulty there is connected with all attempts to explain the numerous ups and downs which they present between any two pulsations of the heart, and also because of the comparatively slight attention which they have had paid to them.

Dr. Galabin, in the paper under consideration, limits his observations almost entirely to the vertical variations in the curves under consideration, paying but little attention to the differences in the relative lengths of systole and diastole which they so clearly indicate, and which cannot be recognised with any degree of accuracy by any other means at our disposal. From a study of the cardiograph trace, he is led to the conclusion that the two most important elevations in the systolic portion of each curve are produced by the muscular movements in the heart itself, because "the more the heart is hypertrophied (by disease) the more prominent in comparison do these two become," and under these circumstances, "the effect of any oscillations, either of the blood or of any solid structures, would become less noticeable in proportion." It is remarked that "Marey's figures (of tracings indicating intracardial pressures) prove that the first, at any rate, of the cardiac impulse is not due to any stroke against the ribs caused by locomotion of the heart as a whole, which could only commence after the opening of the semilunar valves," because "the aortic valves do not open until the ventricular pressure has nearly reached its first maximum." It must, however, be noted that other tracings, obtained by the same illustrious physiologist, demonstrate equally clearly that the maximum of intracardial pressure is reached some appreciable time before the first major systolic cardiograph rise in the trace from the chest-wall, so that it may still be reasonably argued that the rise referred to depends upon the locomotion of the heart *en masse*.

To explain the second main systolic rise, Dr. Galabin makes a statement which needs considerably more demonstration before it can be considered to be proved. He refers to "inverted tracings," by which are understood curves in which all the rises in an ordinary trace are represented by depressions, in such a way that "to see more clearly their correspondence with positive tracings they should be turned upside down and read from right to left," instead of from left to right. Are we to believe, on the simple dictum of Dr. Galabin that *inverted tracings*, as above explained, are developed; that every elevation in the apex cardiograph trace is the result of a movement which is represented by a fairly proportionate fall in a trace a little distance from that spot; that every apical propulsion is a lateral suction? This may possibly be the case, but it requires a considerable amount of proof before it can be accepted as true. The relative duration, or, in other words, the horizontal projections of the different undulations, is not in favour of the assumption, which seems to be based on an accidental similarity between that apex trace and the reversed one from its neighbourhood. Till Dr. Galabin introduced his view, it has been assumed that the negative trace differs from the other positive trace in the fact that in the latter some of the undulations are longer in the up than in the down stroke; whilst in the former the reverse is the case. There is need for positive disproof of this explanation before the other is even considered.

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* A correspondent in NATURE.—ED.

Dr. Galabin concludes that the second main systolic rise "corresponds in time to the maximum contraction of the ventricle," and that it is due to the locomotion of the heart, dependent on the consequent injection of the aorta and the propulsion of the blood. This explanation might be tenable were it not for the results obtained by the employment of the hæmodromometer of Chauveau, tracings taken with which can be found in Marey's "Circulation du Sang" (p. 273). These show that there is a regurgitant current in the carotid arteries for some appreciable period *before* the closure of the aortic valve, which can only exist in connection with a similar one in the ventricular cavity. It is the hæmodromometer trace which has led the writer of this article to lay more than usual stress on the interval between the termination of the cardiac systole and the moment of closure of the aortic valves, termed by him the diaspasis.

Dr. Galabin remarks, "Mr. Garrod attributes the elevation *d* (the first main systolic rise), solely to the locomotion of the heart caused by the lengthening of the aorta. The rise *f* (the second main rise) he considers to intervene between the end of systole and the closure of the aortic valves, and to be due to the initial relaxation of the ventricle. It appears to be impossible that the relaxation of the ventricle, apart from its repletion, could produce an elevation in the curve except in those cases in which its hardening produces a depression either at the commencement or towards the conclusion of systole." In the explanation here referred to the elevation under consideration is, however, not supposed to be the result of the relaxation of the muscular walls of the ventricles, or to have anything to do with that phenomenon, but to be caused by the reflux of blood from the aorta and pulmonary artery into the ventricles which, when it has attained a sufficient velocity, closes the semilunar valves.

Dr. Galabin, by employing the stethoscope in conjunction with the cardiograph, watching the development of the trace whilst listening to the heart-sounds, has been able to satisfactorily verify the observation that the first sound occurs during the primary up-stroke, and that the instant at which the second sound is heard corresponds to a point on the principal down-stroke, and before the succeeding small and constant rise. This is further verified by the superposition of the sphygmograph trace on the cardiograph trace taken at the same time, a method which has elsewhere been shown to lead to particularly important theoretical results.

No particular stress is laid by Dr. Galabin on the peculiarities of the cardiograph trace associated with different rapidity of pulse and nothing else. The thorough study of the subject necessitates this point being taken into consideration, as is demonstrated by the great differences there are always found in the curves derived from the same individual when the heart beats at say 45 and 125 a minute.

Most of the paper under consideration is devoted to pathological points, especially mitral stenosis or contraction. With this we cannot here deal. One particularly interesting tracing proves that in some extremely slow pulses (*e.g.* twenty-five a minute) there may be an abortive attempt towards an intermediate contraction, perceptible in the cardiograph tracing, but not seen in that from the arterial pulse.

Whilst on this subject it may be mentioned that Dr. C. Hanfield Jones has recently read a paper before the Royal Society on reversed sphygmograph tracings, or tracings in which the systole is represented by a fall instead of a rise. These he explains on the assumption that they are produced by the brass end-pad of Dr. Sanderson's modified instrument resting on the artery instead of the spring-pad. This is no doubt the true cause in many cases; these tracings are, however, in our experience sometimes produced when Marey's unmodified instrument is employed. They may sometimes result from the fact that a curved artery is, during systole, rendered part of a larger curve, and so slips from under the spring-pad at that time.

A. H. GARROD

SIR JAMES KAY-SHUTTLEWORTH ON SCIENTIFIC TRAINING

ON the occasion of presenting the prizes to the successful students at the Giggleswick Grammar School, near Settle, on July 28, Sir J. Kay-Shuttleworth made some forcible remarks on the above subject. Sir James points out with so much wisdom the relative position which science and literature ought to hold in the training of youth, that his remarks deserve the serious attention of all interested in education. Our columns constantly bear witness to the increasing prominence given to science in education, both at the higher schools and universities. Sir James, after noticing this and other features in the progress of the Giggleswick School, and referring to some of the results of the training of the school, went on to say:—

"You will perceive that among them are proofs of the influence of the practical teaching in natural science in opening a career to our pupils in the universities. In the growth of any institution on a new basis, time must be allowed for its development. Difficulties will be encountered in discipline, in domestic management, and in the attainment of the ideal to which its course of studies is expected to rise. Yet it is well to keep that ideal closely in view as the goal of all efforts; to retain a firm hold on the principles of action, and while confessing the length and the arduous character of the way, to press forward, undismayed by any partial failure, towards the summit of our hopes. I find in the examination papers a continually higher standard. They embrace a wide range of studies. But it must not be supposed that we are so presumptuous as to expect that even the *élite* of the school could attain a high degree in the whole range of these studies. No error could be more fatal than that they should be obligatory on all our pupils. Indeed, we must, in the first place, point out that in consideration of the prominence given to modern languages and to practical instruction in natural science, Greek is not among the subjects comprised in the scheme of the school, though it will be taught to all boys preparing for the universities, or for any of the public examinations. To determine how best the faculties of those not gifted with average energy and capacity can be developed requires a delicate and thoughtful discrimination. But the curriculum is open to boys in proportion to the mental and physical vigour which they bring to the task. I have said that Greek is not one of the subjects of instruction made obligatory by the scheme, and the reasons for this will become more apparent as I proceed, but among these reasons is no want of appreciation of the ancient classical literature, or of the classical languages as means of mental culture. It may, therefore, be desirable to say that we appreciate the treasures bequeathed to us by them in philosophy, poetry, history, and art, and in the principles of jurisprudence." After speaking in high terms of the value of the classical languages as pedagogical instruments, Sir James went on:—

"But while we thus emphatically express our sense of the value of the classical languages as instruments of mental training and sources of the highest literary culture, the curriculum of this school includes pure and applied mathematics. These studies, which stretch back to the period of Greek civilisation, have grown with the development of astronomical and physical research. They are the instruments of the abstract investigation of physical laws. But we have also sought to place the school practically in relation with natural science. The question has been much discussed whether science should be thus taught through the whole school course, or whether it should be interstratified with the other studies. We shall endeavour to solve these questions by introducing in the junior forms the cultivation of the faculties of observation by the practical study of botany and physical geography, for both of which this neighbourhood affords considerable opportunities. For somewhat more advanced students we have built a good chemical laboratory, and we are about to extend this building so as to provide separate rooms and apparatus, and for the practical study of experimental physics. The thorough knowledge of any branch of experimental science involves an acquaintance with the instruments and modes of investigation, as well as skill in manipulation. These are not to be acquired from books. It is indispensable that pupils should become familiar with the phenomena of the operation of natural forces. They must learn to observe, to practise the philosophy of induction by following the footsteps of the great masters of research in preparation for independent efforts. The faculties exercised in such pursuits are not altogether the same as those employed in literary studies. They may be compared without the depreciation of either. The student of literature has opportunities to cultivate what is metaphysical—whatever relates to art, to poetry, to history, philosophy, or language; while the student of nature may more successfully develop the faculties of observation and those brought into play in the processes of inductive and deductive reasoning. The search for hidden truths trains the ripe student in habits of scrupulous exactitude. To record such observations is an exercise in accuracy of thought and language.

"The scientific habit of mind which is the result of a thorough practical training in one or more branches of science is not to be attained by any devotion to language or literature, just as the development of taste in literature, or of critical skill, or of the power of philological research and discovery cannot be gained in the laboratory. These distinctions between literature and science are in harmony with the diverse capacities of boys, and they may be employed as auxiliaries in the development of boys of limited or one-sided capacity. Some pupils who have low grammatical and linguistic power may yet exhibit facility in mathematical processes. Others in whom both these faculties are feeble, awaken to intellectual life as observers of nature. To some minds the facts and principles of science become easy only when they are in contact with the actual phenomena. Hence one part of the value of practical studies in the field and the laboratory. It may be confidently asserted that when any of these classes of mental power is feeble, the development of that part of the brain which is most easily awakened to activity will communicate vigour to the rest; the whole brain will become more healthy and active. A boy incapable of successful literary effort, but who has power as an observer, may, by that form of mental culture, by-and-by become more capable of literary application and success. Thus the literary, the mathematical, and the practical scientific studies of schools become, in the hands of a thoughtful and skilful master, preparatory or co-ordinate instruments of mental development.

"There has been of late a new era in the development of the natural sciences. This commenced with the discoveries of great mathematicians and astronomers, and extended to every department of physical research. After Kepler and Newton, mathematics in their application to experimental physics and astronomy established themselves, especially at Cambridge, as a prominent part of the studies of the European Universities. But during the present century, the rapid development of every department of natural science has created new claims for the introduction of new courses of study, for which the universities are gradually increasing their means and appliances, and towards the successful cultivation of which they are extending their honours and rewards. What happened at the revival of learning with respect to the classical literature is about to happen in the fuller recognition in the universities of every department of natural science. The Chancellor of the University of Cambridge has recently munificently founded a physical laboratory in that university. Certain of the colleges have established chemical and biological laboratories. The Geological Museum lectures and fieldwork continue to develope. These are preliminary steps towards practical instruction in every department of natural science. At Oxford, the university has built an admirable museum, with which are connected laboratories for chemical and biological studies, and for those of experimental physics and geology. Certain of the colleges have also laboratories, and readers or demonstrators of practical science. The Commission on Scientific Instruction, which has just closed its five years' labours, has made many suggestions as to the facilities to be granted to students of natural science in both universities. For example, it recommends the freer admission of those who are successful to the honours of the university, as well as to the scholarships, fellowships, and government of the colleges. The Commission had such opportunities of ascertaining to what extent these recommendations expressed the opinions of the governing minds of the universities, that there can be no doubt that no insurmountable obstacle will be encountered in the establishment of studies in natural science in a position, in relation to their honours and rewards, which will duly represent the part which science has to play in the education of the country.

"The methods and results of natural science have now so far affected all our modes of thought that they claim their place in the arena of all forms of discussion. They must, therefore, also take their place in the studies of the public and grammar schools, and of the colleges and universities which would fitly train men for the work of life. It would be a grave disadvantage to this nation if its rulers in Parliament and in the Cabinet should represent chiefly literary culture, without a familiarity with the physical sciences. Such a result could not now long exist without a neglect of opportunities of promoting scientific culture and research, which would be injurious to the education of the country and prejudicial to the development of its material resources. Perhaps it would be a much graver misfortune if there should grow up in the country two forms of thought—one derived from the exclusive contemplation of the metaphysical, and the other resulting from purely physical and materialistic studies. Moreover, to a man of education, however ripe and complete may be his classical accomplishments, it must be a great misfortune to have had no training in the natural sciences. He must have a sense of partial development, and of the deprivation of a great source of mental pleasure. These are, doubtless, among the reasons why, in the great public schools, instruction in natura science has recently been introduced by the appointment of skilled teachers, by the building of laboratories and the establishment of museums, and by the regulations of the commission of public schools as to the time to be allotted to such studies. Among our provincial grammar schools Manchester has provided laboratories and the means of highly skilled scientific instruction. At Burnley, also, laboratories have been built, and the head master, Mr. Hough, is distinguished by his scientific knowledge and practical skill. He, doubtless, will diligently employ the means at his command. The Commission on Scientific Instruction has carefully collected the experience of the schools which have introduced practical scientific teaching. They strongly recommend that such instruction should take its place at the side of that which is literary throughout the whole school course. We had practically anticipated this suggestion at Giggleswick. I do not prominently put forward the adaptation of such studies to the wants of the great manufacturing districts of Yorkshire, Lancashire and Cumberland, which are contiguous to us, or of the Durham and Northumberland coalfield. Yet many of the sons of wealthy men in these districts, as well as of those engaged in scientific professions, will complete their education at school. In these trades and professions the practical commencement of a scientific training is often of great value. As I have already said, it forms the scientific habit of mind; it familiarises the youth with the phenomena of the operation of natural laws, and with the manipulation of instruments. It developes the faculty of observation and the power of inductive and deductive reasoning. Moreover the facts of physical science learned in the laboratory are an invaluable possession to the engineer, the chemist, the miner, the physiologist, and to every professional man who has to use these facts, principles, and processes as a part of his daily occupation. This school is intended to offer, in the first place, a sound preparation in elementary knowledge in the English language, its grammar, composition, and some acquaintance with English history and literature. Within the range of its studies are the ancient classical literature and modern languages. It would fail in its purpose if the humble elements of arithmetic were not faithfully cultivated as the basis of mathematical knowledge and scientific calculation. It is on this broad basis that we wish and hope to rear the structure of a sound and scientific culture.

"The questions which the governors of this school have attempted, through years of patient labour, to solve, are also awaiting solution in all similar schools. What are in future to be the relative positions of the literary and scientific education of our youth? How, as in this school, can the financial resources be developed so as to provide laboratories, and a larger skilled staff of teachers, in order to ensure a sound literary culture, together with scientific instruction? Inseparable from these questions is the formidable one, Whence are the skilled teachers of science, capable of giving practical instruction in laboratories to be provided, if science in this sense is to form part of the curriculum of all schools? Where the income of the school is small, that difficulty is at present insurmountable, for a separate science master cannot be afforded in such schools. Nor will it be removed until some means be devised for the training of teachers by which they will be enabled to add practical skill in scientific instruction to a sound basis of literary culture. Then a single master may fulfil the double function in a school. The commission on scientific instruction points to this, among many other reasons, for the establishment, within the universities and elsewhere, of a system of training for masters of schools above the elementary in the art and practice of teaching, and in a practical knowledge of science. The governors of this school of King Edward the Sixth of Giggleswick have not been negligent of the bearing of their labours on these wide general questions. So far as they have proceeded, they are satisfied that a sound literary culture may not only subsist with practical instruction in science, but that, under earnest and thoughtful guidance, these departments of instruction may each contribute to the intellectual activity and to the success of every form of teaching in the school."

THE INTERNATIONAL GEOGRAPHICAL CONGRESS AND EXHIBITION

THIS Congress, which has been looked forward to with considerable expectation, was opened in the Salle des Etats of the Tuileries, on Sunday last, in presence of the President of the French Republic, many of the dignitaries of State, foreign ambassadors, and other eminent persons. There was a large attendance of the general public, and addresses were given by the President of the Congress, Admiral de la Roncière le Noury, Baron von Richthofen, Sir Henry Rawlinson, and other delegates of the various nations represented at the Congress.

The regular work of the Congress commenced on Monday, and the sittings will be continued till the 11th inst., when a distribution of medals will take place. We believe a few prizes will be awarded to England, but not many, as our country has contributed but scantily to the exhibition. To-day a visit will be made to the Paris Observatory, and to-morrow one to the Historical Museum of National Antiquities (mostly pre-historic) at St. Germain.

Juries have been appointed to decide on the awards in the various sections of the Exhibition, and a notable feature of these is that not a single Frenchman has been appointed a president; this, we believe, is the result of characteristic delicacy on the part of the French authorities. Col. Montgomerie and Major Wilson are the English representatives.

The Exhibition continues to be well attended, and we hope the receipts will be sufficient to reimburse the Committee, who have become responsible for a large sum, the French Government and Geographical Society having contributed a very small amount.

In the English Section the books of photographs illustrating the people of India and China and the Chinese have proved very attractive. The photographs exhibited in the Russian annexe are very numerous, and relate to people of every tribe and condition inhabiting the empire. Austria has also been very successful in this respect, having exhibited photographs and drawings illustrating the chief incidents of the *Tegethoff* Polar Expedition.

A special room has been set apart for the several Alpine clubs, which have been created in imitation of the English Alpine Club. The publications of the parental association, and the scientific and other apparatus used in Alpine climbing by the English, French, and Italian clubs, are exhibited, and are inspected with evident interest.

The French Government exhibits the results of the missions sent out by the Ministry of Public Instruction. These have been numerous and successful. Independently of the Transit of Venus Expedition, we must mention a series of pictures showing the Bay of Santorin, in the several successive stages of creation of the new volcanic island. These illustrate happily how continents come into existence.

The Hall of National Antiquities (Pre-historic) is a compendium of the Saint Germain Museum, which will be visited by the Congress. A number of highly instructive maps, showing the distribution of relics of the Stone Age, Iron Age, &c., have been published, and are exhibited by the Historical Commission on the Gauls, which was created by Napoleon III. while writing his "Life of Cæsar," and will be continued for a lengthened period.

Amongst the real curiosities of the Exhibition, we must mention a microscopic photograph of the French map by the staff. This photograph was executed by M. Dagron, the inventor of microscopic photographs for carrier pigeons during the war. The 250 maps, covering a space of more than a hundred yards square, are so reduced on glass, that they can be packed in a portfolio weighing half a pound when full, and examined with a small microscope with perfect facility and clearness.

M. Bouvier, a French naturalist, has presented a collection of almost all the known species of *Algæ* collected in the fish market at Paris.

NOTES

THE following are the officers of the forty-fifth meeting of the British Association which will commence at Bristol on Wednesday, August 25, 1875:—President-elect—Sir John Hawkshaw, F.R.S. Vice-Presidents-elect—The Right Hon. the Earl of Ducie, F.R.S., the Right Hon. Sir Stafford H. Northcote, Bart., F.R.S., the Mayor of Bristol, Major-General Sir Henry C. Rawlinson, F.R.S., Dr. W. B. Carpenter, F.R.S., W. Sanders, F.R.S. General Secretaries—Capt. Douglas Galton, F.R.S., Dr. Michael Foster, F.R.S. Assistant General Secretary—George Griffith, F.C.S. General Treasurer—Prof. A. W. Williamson, F.R.S. Local Secretaries—W. Lant Carpenter, F.C.S., John H. Clarke. Local Treasurer—Proctor Baker. The sections are the following:—Section A: Mathematical and Physical Science. President—Prof. Balfour Stewart, F.R.S. Section B: Chemical Science. President—A. G. Vernon Harcourt, F.R.S. Section C: Geology. President—Dr. T. Wright, F.R.S.E., F.G.S. Section D: Biology. President—P. L. Sclater, F.R.S. Department of Zoology and Botany, Dr. P. L. Sclater, F.R.S. (President), will preside. Department of Anatomy and Physiology. Prof. Cleland, F.R.S. (Vice-President), will preside. Department of Anthropology. Prof. Rolleston, F.R.S. (Vice-President), will preside. Section E: Geography. President—Major-General Strachey, F.R.S. Section F: Economic Science and Statistics. President—James Heywood, F.R.S., Pres. S. S. Section G: Mechanical Science. President—William Froude, F.R.S. The First General Meeting will be held on Wednesday, August 25, at 8 P.M. when Prof. Tyndall, F.R.S., will resign the chair, and Sir John Hawkshaw, C.E., F.R.S., President-elect, will assume the presidency, and deliver an address. On Thursday evening, August 26, at 8 P.M., a *soirée*; on Friday evening, August 27, at 8.30 P.M., a Discourse by W. Spottiswoode, LL.D., F.R.S., on "The Colours of Polarised Light;" on Monday evening, August 30, at 8.30 P.M., a Discourse by F. J. Bramwell, C.E., F.R.S., on "Railway Safety Appliances;" on Tuesday evening, August 31, at 8 P.M., a *soirée*; on Wednesday, September 1, the Concluding General Meeting will be held at 2.30 P.M. A special lecture to working-men will be given by Dr. Carpenter, F.R.S., on the evening of Saturday, Aug. 28; the subject will be "a piece of limestone." The Local Committee have done everything in their power to make the Bristol meeting a success. All the non-local sectional secretaries will be lodged at the Queen's Hotel, close to the reception-room, at the Local Committee's expense; this will no doubt conduce much to the easy working of the meeting. The experiment of a room for the exhibition of specimens and apparatus, tried first last year at Belfast, will be repeated this year. The President will be the guest of the Mayor, who will occupy for the first time the new Mansion House just given to the city by Thos. Proctor, Esq. Most of the other office-holders, as also all the foreign members, who have intimated their intention of being present, and several English members, have received private invitations from gentlemen resident in Bristol and neighbourhood. Many other hospitable arrangements have, we believe, been made, and altogether, so far as enjoyment and comfort are concerned, this promises to be one of the most satisfactory meetings of the Association. As we previously intimated, a specially prepared Guide, compiled by several gentlemen, will be published by Wright and Co., of Bristol; a lodging list with useful map will be issued this week. The whole of the Victoria Rooms, Clifton, will be used as a reception-room. All the evening meetings and *soirées* will take place at the Celston Hall, and satisfactory arrangements have been made for the meetings of sections. Several interesting excursions have been arranged for, including two to the Mendips, and handsome offers of entertainment have been made by those gentlemen to whose neighbourhood the excursions are to be made.

A NEW physical observatory is to be erected at Fontenay, the head of which will be M. Janssen. It will be erected on the very spot where it was intended to build one when it was proposed some years back to remove the Paris Observatory. In a few months, then, Paris will have four observatories—the National, the Physical, and two meteorological observatories—one at Montsouris under M. Marie-Davy, and another which is being built at the Acclimatisation Gardens. It is said that some members of the Municipal Council will propose to connect all these observatories with the National one by a special wire to register automatically all the meteorological observations by the Rysselberghe process, which we noticed last week in connection with the Geographical Exhibition.

THE Smithsonian Institute and the Indian Bureau are engaged in forming for the U.S. Centennial, a collection exhibiting the past and present history of the Aboriginal races of America.

"THE German Abyssinian Company."—A company has been incorporated in Berlin which proposes to found at Choa, the most southern province of Abyssinia, a permanent settlement, in order from thence to send out scientific expeditions into the unexplored portion of Africa, and to develop the commerce of the country. The objects of the Company are, however, supposed to be more commercial than scientific.

THE Khedive has issued a decree ordering the enforcement of the metrical system in Egypt from the 1st of January, 1876.

DR. HAWTREY BENSON, of Dublin, writing to the Dublin *Daily Express* under date July 27, describes a remarkable shower of small pieces of hay which he witnessed at Monkstown that morning. It appeared in the form of "a number of dark flocculent bodies floating slowly down through the air from a great height, appearing as if falling from a very heavy dark cloud, which hung over the house." The pieces of hay picked up were wet, "as if a very heavy dew had been deposited on it. The average weight of the larger flocks was probably not more than one or two ounces, and, from that, all sizes were perceptible down to a simple blade. The air was very calm, with a gentle under-current from S.E.; the clouds were moving in an upper-current from S.S.W." The air was tolerably warm and dry, and the phenomenon is thus accounted for by Dr. J. W. Moore: "The coincidence of a hot sun and two air currents probably caused the development of a whirlwind some distance to the south of Monkstown. By it the hay was raised into the air, to fall, as already described, over Monkstown and the adjoining district."

IN the Paris *Bulletin International* for July 30 last Prof. Raulin of Bordeaux gives the result of an examination of a comparison of the gross amount of the rainfall for the ten years 1851-60 with that for the ten years 1861-70, from which it is shown that, as regards the southern half of France, the rainfall during the former of these decennial periods exceeded that of the latter at forty-six out of the fifty-three stations at which observations were made for the twenty years. A similar distribution of the rainfall during these two decennial periods appears to have taken place, with few exceptions, over a large area, embracing the British Isles, France, Germany, Italy, Spain, the basin of the Mediterranean, and Algiers. The point is an interesting one, and we hope that meteorologists will inquire how far the rainfall observations of their respective countries agree with the result obtained by Prof. Raulin for the southern half of France.

IN the *Journal* of the Scottish Meteorological Society for 1874-5, just published, will be found a long and elaborate paper by Mr. A. Buchan and Dr. Mitchell, on the Influence of Weather on Mortality from different diseases and at different ages; some of the results which have been arrived at will be found in an abstract by Mr. Buchan, which we publish to-day. Other papers in the *Journal* are on proposed portable Iron Barometers, and on a simple form of Anemometer, by Mr. T. Stevenson, C.E.; Meteorological Register at Inveresk for 1874; Table of Observations connected with the periodical return of the Seasons; Additional Rainfall returns for 1874; and Meteorological returns, with notes of the prevailing weather and state of vegetation at the Society's stations for the year; besides reports of the general meetings of the Society held on July 3, 1874, and February 10, 1875.

IT is expected that an important meeting of the Council of the Paris Observatory will be held to-day, a member of the Academy having been desired to explain his assertions relating to astronomical observations. The results will very likely be made public.

THE recent French inundations have recalled to memory an experiment which was tried twelve years ago before Napoleon III. The design was to manufacture mattresses of cork, so that any one on board a ship or in a house which could be flooded would have in his bed a ready-made raft capable of floating under a weight of more than 1 cwt. for any length of time. Cork is a material so soft that mattresses made of it are not inferior to any other for comfort.

A MEMORIAL in marble of Sir John Franklin was uncovered on Saturday by Sir George Back in Westminster Abbey. The monument has been erected by the late Lady Franklin, and contains some appropriate lines by Mr. Tennyson.

THE recent attack upon Lieut. Conder's Palestine exploring party occurred near Acre. Lieut. Conder was badly, but not dangerously, wounded.

THE election to the vacant Professorship of Medicine in the University of St. Andrews will take place on Sept. 22 next.

THE *Shearwater*, which was commissioned by Capt. Nares (now commanding the Arctic Expedition) on July 20, 1871, for surveying service on the Mediterranean Station, arrived at Sheerness on July 23 last. In Saturday's *Times* will be found a brief account of the work done by the ship during her four year's service. During part of the cruise in the Mediterranean Dr. Carpenter was on board to investigate the results of soundings and dredgings. Commander W. J. L. Wharton took command of the ship on Capt. Nares leaving to join the *Challenger*. After having been two years in the Mediterranean the *Shearwater* proceeded to Zanzibar, in order to survey the island and the opposite coast. In February 1874 the ship proceeded to the Cape of Good Hope, leaving Cape Town on July 14 with the Rodriguez Transit party. At Rodriguez the ship was constantly employed on work connected with the Transit, running meridian distances, surveying the island, and assisting the shore party in various ways. After landing the Transit party at Mauritius, the *Shearwater* again proceeded to Zanzibar to continue surveying work, officers and men, however, suffering greatly from fever. Zanzibar was left on May 8, and the *Shearwater* reached England as we have said on July 23 last. During the four years the ship has been in commission, she has surveyed in detail 790 miles of coast line and sounded closely over an area of 5,900 square miles. Most of the earlier surveys have been published.

IN the new part for May 1875 of Hoffmann's *Niederländisches Archiv für Zoologie* there are two papers of interest—one by Dr. A. A. W. Hubrecht, on the Nemertines of the Gulf of Naples, the other by Prof. P. Harting, on the eggs of Cyanea-Otoliths of Cyanea, and Chrysaora-nerve ring and organs of sense of Eucope-Chromatophores of the embryonic Loligo; being notes made during a stay at Scheveningue.

THE following candidates have been successful in the competition for the Whitworth Scholarships, 1875:—Joseph Harrison, 21, Mechanical Engineer; George Goodwin, 20, Mechanical Engineer; John Alldred, 21, Locomotive Engine Fitter; Franklin Garside, 20, Pattern Maker; Frank W. Dick, 21, Mechanical Engineer; Joseph Poole, 20, Fitter and Turner.

THE forty-third meeting of the British Medical Association opened on Tuesday in Edinburgh. Sir Robert Christison, the President, in his inaugural address, treated of the subject of Medical Education, entering into a complete history of the Medical School of Edinburgh.

THE twelfth number of Mr. Hermann Strecker's quarto work upon indigenous and exotic lepidoptera has lately been published by him at Reading, Pennsylvania, and contains, as usual, one plate filled with figures of butterflies. Among them are several very conspicuous forms, the most prominent being that called by him *Eudamonia Jehovah*, a term to which very serious objection has been raised on account of its apparent irreverence, but which he stoutly defends. Several new species are described; one of them being figured under the name of *Hepiolus thule*.

THE Report of the Agri-Horticultural Society of Madras, for 1874, shows that the Society is effecting much substantial benefit in its district, especially in the assistance and encouragement it offers in the introduction and cultivation of useful plants, that will thrive in the different climatal regions of Southern India, European vegetables, fibre-producing plants, coffee, tea, tobacco, indigo, &c. The cultivation and preparation of tea is strongly encouraged, and substantial prizes awarded for the best sample of different sorts. Some of the samples submitted to the brokers at Calcutta for their judgment are described as being of superior quality. A flower, fruit, and vegetable show is held annually, and it is worthy of note that all the prizes for ferns and other plants with ornamental foliage were gained by native gentlemen. There was last year a special class for the vegetable productions of native market gardeners, and the European vegetables exhibited are reported to have been of fair quality. The "list of new plants introduced in 1874" is remarkable for the very small proportion of correctly spelt names.

IN reference to Tidal Mills (vol. xii., p. 212), a correspondent writes that they have engaged the attention of Gregory, Barlow, Belidor, and Aldini, as will be seen on turning to the article on Tidal Mills in the "Penny Cyclopædia."

THE additions to the Zoological Society's Gardens during the past week include a Punjaub Wild Sheep (*Ovis cycloceros*) from Muscat, presented by Commander Yarforth; a Ruffed Lemur (*Lemur varius*), a Mongoose Lemur (*Lemur mongoz*) from Madagascar, two Rheas (*Rhea americana*), a West Indian Rail (*Aramides cayennensis*) from S. America, a Golden-naped Amazon (*Chrysotis auripalliata*) from Central America, two Yarrell's Curassows (*Crax carunculata*) from S.E. Brazil, two Razor-billed Curassows (*Mitua tuberosa*) from Guiana, deposited; a Short-tailed Muntjac (*Cervulus micrurus*), a Crested Pigeon (*Ocyphaps lophotes*), five Amherst Pheasants (*Thaumalea amherstiæ*), and six Japanese Pheasants (*Phasianus versicolor*), bred in the Gardens.

THE MORTALITY OF THE LARGE TOWNS OF THE BRITISH ISLANDS IN RELATION TO WEATHER*

THE materials for this inquiry have been obtained from the Weekly Reports of the Registrars'-General for England and Scotland for the ten years, 1865–74. The data discussed embrace returns of deaths from all causes and at all ages, deaths of persons under one year of age, of persons above sixty years of age, and deaths from diarrhœa. The weekly averages have been calculated on the annual rate of mortality per 1,000 of the population.

The results for every one of the large towns show during the winter months an excess above the average mortality. A regards the English towns, that excess is greatest at Norwich, Wolverhampton, and Nottingham, and least at Bradford, Leeds, Salford, and most other towns in the north. In Scotland the winter excess is greatest at Aberdeen, and least at Leith and Greenock. At Dublin, the largest monthly mortality, 22 per cent. above the weekly average, occurs during February and March, being from a month to six weeks later than the time of the maximum of the English and Scottish towns.

In all the English towns, the minimum mortality of the year is in the spring months, the amounts below the averages of each town being greatest at Norwich, Wolverhampton, Birmingham, Leicester, and Nottingham. In Scotland, on the other hand, autumn is the healthiest season. In Glasgow and Edinburgh the deaths fall about 20 per cent. below the average in the month of September.

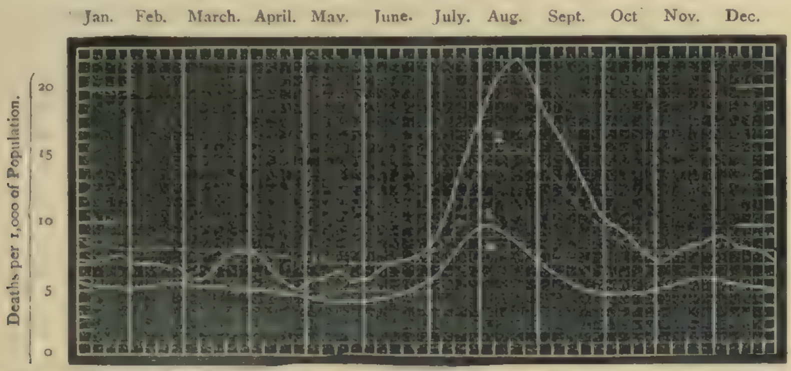

FIG. 1.—Showing the Weekly Deaths among Infants under one year of age on the Annual Mortality per 1,000 of the whole population. For Leicester, Curve 1; Liverpool, 2; London, 3; and Bristol, 4.

It is, however, to the summer death-rate that the greatest interest attaches, since it is during the hottest weeks of the year that the differences in the rates of mortality of the different British towns stand most prominently out. During the period of high temperature in summer, *every one of the large towns of England shows an excess of deaths above the average*, with the single exception of Bristol, at which place, while there occurs an increased mortality at this season, it only comes near to, but never quite reaches, the average. As regards the time of absolute maximum, it occurs in London in the end of July, but at other places more generally about the beginning and middle of August. Taking any two consecutive weeks which indicate the highest mortality, the excess per cent. above the average is for Wolverhampton, 6; Manchester, 8; Portsmouth, 12; London, 14; Hull, 20; and Leicester, 47. The excess above the average at Leicester being thus eight times greater than that of Wolverhampton.

In Scotland no town exceeds its average during the hottest weeks of the year, but on the contrary the death-rate everywhere is under the average, and in most cases very considerably so. At Aberdeen the rate below the average is 18 per cent. during each of the months, July, August, and September; and at Dublin the annual minimum occurs in July, when the death-rate falls 25 per cent. below the average during the second and third weeks of that month. Though none of the Scottish towns exceed the average at this season, yet Glasgow and Dundee show a decidedly increased mortality, their curves though rising towards never quite reach the average.

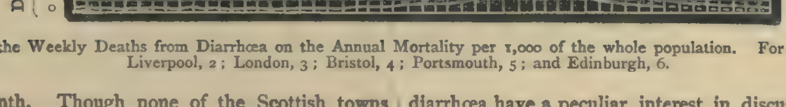

FIG. 2.—Showing the Weekly Deaths from Diarrhœa on the Annual Mortality per 1,000 of the whole population. For Leicester, Curve 1; Liverpool, 2; London, 3; Bristol, 4; Portsmouth, 5; and Edinburgh, 6.

In a paper on the mortality of London by Dr. Arthur Mitchell and myself, it has been shown that if the deaths of children under one year of age be deducted from the total mortality, the summer excess disappears from the curve; and it is further shown that, if deaths from diarrhœa be deducted from the whole mortality, the summer excess disappears equally as in the former case. Now, these results hold good for every one of the large towns for which the required data have been published. It follows, therefore, that curves of the death-rate for infants and diarrhœa have a peculiar interest in discussions of this nature. Fig. 1 gives for Bristol, London, Liverpool, and Leicester curves representing the average weekly mortality among children under one year of age, calculated on the annual mortality of 1,000 of the whole population, the averages being dealt with after Mr. Bloxam's method, according to which each average is calculated so as to include that of the week immediately preceding and that of the week immediately following.

Of all the large towns of England, Bristol has the least summer excess of infant mortality, the highest average of any week being only at the rate of eight calculated on an annual mortality of 1,000 of the whole population. In London, the rate rises to ten in the end of July and beginning of August; and in Liverpool it rises to sixteen, a rate which is also reached by the deaths in Leeds, Hull, and Sheffield, and closely approached by a number of the other English towns. At Leicester, however, it shoots up to twenty-two, and twenty-four on the second and third weeks of August. As regards the whole year, the lowest averages of infant mortality are—Portsmouth, 4·9; London, 5·7; and Bristol, 5·9: and the highest, Leeds, 8·4; Liverpool, 9·1; and Leicester, 9·4. The season of minimum infant mortality is everywhere during the spring months in the sixteen large towns of England. The smallest spring mortality occurs at Portsmouth, the smallest summer mortality at Bristol, the largest summer mortality at Leicester, and the largest mortality during the other nine months of the year at Liverpool.

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* The substance of this paper was read at the general meeting of the Scottish Meteorological Society, held at Edinburgh on July 13, 1875.

Fig. 2 shows the distribution of the mortality from diarrhœa through the weeks of the year, in six large towns, the curves being constructed similarly to, and on the same scale as, those of Fig. 1.

The differences in the rates of mortality from diarrhœa indicated by these curves, which are strictly comparable *inter se*, are very great, and a comparison of the two extremes, Leicester and Edinburgh, is startling; the figures showing that for every one who dies from diarrhœa in Edinburgh during the summer months, eight die in Leicester from the same disease in proportion to the population.

From the beginning of November to the summer solstice, the mortality from diarrhœa is everywhere small, being double, however, in Liverpool and Manchester as compared with London and Portsmouth. It will be observed from Fig. 2 that the curves begin to open out and diverge from each other in the end of June. The curve for Edinburgh on no week reaches the annual rate of 2 per 1,000 of the population. The highest for any week are—Bristol, 3·6; Portsmouth, 3·9; London, 5·5; Liverpool, 10·5; and Leicester, 15·8, these two last places again standing higher than any other of the towns.

The following is a list of all the large towns of Great Britain, arranged in the order of the greater or less prevalence of fatal cases of diarrhœa, during July, August, and September, the figures being the average weekly death-rate for the thirteen weeks, calculated on the annual mortality per 1,000 of the population:—*In England:* Leicester, 9·56; Salford, 7·15; Leeds, 7·02; Manchester, 7·00; Liverpool, 6·28; Sheffield, 6·20; Birmingham, 5·78; Hull, 5·56; Nottingham, 5·36; Norwich, 5·02; Newcastle, 4·61; Bradford, 4·42; Wolverhampton, 4·03; Sunderland, 3·89; London, 3·45; Portsmouth, 2·94; and Bristol, 2·38; and *in Scotland:* Dundee, 2·14; Glasgow, 1·90; Greenock, 1·75; Paisley, 1·71; Leith, 1·45; Edinburgh, 1·23; Perth, 1·08; and Aberdeen, 0·96.

From these results it will be seen that the influence of climate is unmistakable. The summer temperature of the Scottish large towns is several degrees lower than that of the English towns, and we see that every one of the Scottish towns has a mortality from diarrhœa lower than the lowest mortality of any one of the English towns. Of all the large towns of Great Britain the lowest death-rate from diarrhœa is that of Aberdeen, which is at the same time characterised by the lowest summer temperature. Further, the diarrhœa mortality of each town is found from year to year to rise proportionally with the increase of temperature, *but the rate of increase differs very greatly in different towns.* This points to other causes than mere weather, or the relative temperature and humidity of the place, as determining the absolute mortality. Thus the summer temperature of Dundee and Perth is nearly the same, and that of Glasgow and Edinburgh is also nearly alike, the excess being rather in favour of Perth and Edinburgh; and yet the diarrhœa mortality of these two towns is respectively less than that of Dundee and Glasgow. It may therefore be assumed that there is something in the topographical, social, or sanitary conditions of Dundee and Glasgow, which intensifies the evil effects of hot weather on the health of the people, so as to swell, for instance, the death-rate from diarrhœa at Dundee to double that of Perth. At Leicester the summer temperature does not exceed that of Bristol; but while the summer death-rate from diarrhœa at Bristol is 2·38, at Leicester it is 9·56; in other words, it may be assumed that there are local peculiarities affecting the population of Leicester, the effect of which is to quadruple the death-rate from diarrhœa in that town as compared with Bristol. It is to these local conditions we must look for an explanation of the great differences in the death-rate of the different towns. The highest average death-rate per annum for the period under discussion is Liverpool 30·6, Glasgow 30·5, Manchester 30·2, Greenock 39·3, and Paisley 29·0; and the lowest is Portsmouth 20·6, London 23·0, and Aberdeen 23·3. Thus, for every two who die at Portsmouth, three die at Liverpool, Glasgow, and Manchester.

These facts suggest large inquiries which call for instant and serious attention. As one of the first steps of the inquiry, it is most desirable to know exactly from a weekly registration of the facts, whether the infant mortality is equally distributed among all infants, however nursed, or whether it may not rather be distributed among them in very unequal proportion, according to the manner in which they are fed. Those, for instance nursed at the breast may be much less liable to succumb to diarrhœa in summer than those fed on cow's milk or those fed on slops. The unusually low temperature of December last very largely increased the death-rate everywhere in the British Islands, particularly from diseases of the respiratory organs and from many diseases connected with the nervous system and the skin. The gross number of deaths registered in the different large towns showed that the excess of deaths thereby caused was very unequally distributed over the country. If there had been a more complete system of registration, for all the large towns, it might have been possible, reasoning from the specific diseases which proved to be unusually fatal at each place, to lay the finger on those local conditions, inimical to health, to which the high rate of mortality in each case was due. During the cold months of the year—December, January, and February—the mortality among females is very considerably in excess of that among males in London; for while during these thirteen weeks the average death-rate among males rises 7·8 per cent. above the weekly average of the year, the death-rate among females rises to 11·2 per cent. above the average. Since the facts of mortality for sex are only registered for all causes and all ages, it is impossible to say from the present system of registration how much of the excess of mortality among females in winter is due to sex, and how much to occupation, or even to fashion.

A comparison of the meteorological with the mortality records shows in an impressive manner the influence of particular types of weather in largely increasing or diminishing the number of deaths from particular complaints. Thus, periods of unusual cold combined with dampness in the end of autumn, cold with drought in spring, cold in winter, or heat in summer, are accompanied with a proportionally increased mortality from scarlet fever, whooping-cough (if these diseases be epidemic at the time), bronchial affections, and bowel complaints respectively. Again, as regards diarrhœa, for example, there appear to be certain critical temperatures, such as 55°, 60°, 63°, and 65°, at which as they are reached, the mortality rises successively to greatly accelerated rates. To work out the problem of the relation of the weather and mortality of our large towns, it is indispensable for the comparison of the different towns with each other, that the system of observation be uniform at all places, particularly as regards the hours and modes of observing the temperature, humidity, and movements of the air, and the rainfall; and it is further indispensable that several meteorological stations be established in each of the large towns.

ALEXANDER BUCHAN

SCIENTIFIC SERIALS

Mental Science Journals, January, April, July.—The January number opens with an article by Samuel Wilks, M.D., "The Study of the Human Mind from a Physiological View." Dr. Wilks finds no more difficulty as regards the relation of the mind and brain than in "the association of other functions with their respective organs." The main purpose of the writer seems to be to show that men are very much of automata. In this he thinks he has followed Dr. Huxley, who however, if he meant anything, meant that men are altogether automata. The illustrations of the automatism of doctors must be alarming to the nervous and ailing. Example: "Up to the present time I have never seen a single case of leucocythæmia of the lympathic glands, or the spleen, or simple idiopathic anæmia, without the patient's having been saturated by iodine, quinine, and iron; but no case is yet recorded of these remedies having done the slightest good."—David Nicholson, M.B., continues his "Morbid Psychology of Criminals," and shows his vigorous common sense in refusing to see that suicide is always an insane act, or that there is any "madness in an idle-minded fellow preferring to live 'like a gentleman' by helping himself directly from moneyed pockets, instead of sweating his life out with a pick and shovel at fourteen shillings a week."—This number contains an interesting paper on the Hallucinations of Mahomet and others, by W. W. Ireland, M.D.—In the April number we find the Morisonian lectures on Insanity for 1873, this time written entirely by Dr. Clouston; the Morbid Psychology of Criminals continues; an article on the Family Care of the Insane in Scotland, by Prof. Friedrich Jolly, of Strasburg, is valuable, inasmuch as it helps us "to see ourselves as others see us," and pleasing, as this time we may look and be not ashamed. "This visit," says Prof. Jolly, "and the information furnished by these gentlemen, as well as a more careful study of the Scottish Reports and their appendices, convinced me that it is no 'Gheel in the North' with which we have to do, but an organisation which rests on a quite different and much sounder basis."—George Shearer, M.D., communicates notes to show that "Diseases of the general nervous system are by no means infrequent amongst the Chinese, but cases of alienation of mind are comparatively few."—Mr. E. Thompson continues and concludes his paper on the Physiology of General Paralysis of the Insane and of Epilepsy. The worst things in the paper are a few unseemly remarks directed against Dr. Hughlings Jackson.—The July number opens with a Chapter on some Organic Laws of Personal and Ancestral Memory, by J. Laycock, M.D.—The Morisonian lectures on Insanity are continued from the previous number.—David Nicholson M.B., furnishes his excellent articles on the Morbid Psychology of Criminals, which we have always read with much pleasure.—S. Messenger, F.R.C.S., writes under the title, "Moral Responsibility," to show that we all are what we are because, given our parents and our circumstances, we could not have been otherwise. The moral of "this theory of no-moral of responsibility" is very good, "we should be more generally charitable in our judgments, more universal in our forbearance." It is a pity that the men who are continually claiming to be the only scientific men cannot reach such simple conclusions without outraging language and common sense in order to show, by the way, that they are not metaphysicians. Mr. Messenger describes the manufacture of thought as similar to the manufacture of gastric juice—the action of the brain is like "that of the stomach, whose peptic glands secrete the gastric juice from the circulating blood, but need the stimulus of food to excite the process." It would be a great advantage to the scientific men of this stamp if they would try "the means of observation which metaphysicians employ," or any other that might help them to see that intelligence is not a juice.

IN the *Scottish Naturalist* for April and July 1875, the difficult subject of the relationship between the mental development of man and of the lower animals occupies a rather prominent place, in a series of articles by Dr. Lauder Lindsay, on "Illustrations of Animal Reason," and one by the Rev. J. Wardrop, on "Animal Psychosis."—The former writer also contributes a paper on "The Auriferous Quartzites of Scotland," in which he brings forward evidence in support of the view long since published by him of the auriferous character of the whole Lower Silurian area of Scotland; the rocks being identical stratigraphically with those of the gold-fields of the province of Otago, in New Zealand.—There are several other good geological papers, especially one by Mr. R. Walker, "On Clays containing *Ophiolepis gracilis*, &c., near St. Andrew's."—The zoological and botanical papers are mostly descriptive, and we have continuations of the "Lepidoptera of Scotland," by Dr. Buchanan White, and the "Coleoptera of Scotland," by Dr. D. Sharp.

THE numbers of the *Journal of Botany* from March to July contain many articles of interest; and nearly every number is now illustrated by at least one original drawing. Those in the numbers now under notice are the fruit of the Bitter Cola, an undescribed species of Clusiaceæ from Wesetrn Tropical Africa, nearly allied to *Garcinia*, several species or new or rare Hymenomycelous Fungi (coloured), *Deidamia Thompsoniana*, a remarkable species of Passifloraceæ, and *Carex ornithopoda*, a newly discovered British species. Besides a number of abstracts and short notes, the following are the more important original articles in these numbers:—Descriptions of a number of new and unpublished species by Dr. Masters, Dr. Trimen, Mr. J. G. Baker, Dr. Hance, and others. In Cryptogamy, Mr. Worthington Smith describes a number of new species of fungi; the Rev. J. M. Crombie the additions to the British lichen flora since his last notice; and Mr. J. G. Baker several new ferns. One of the best papers in these numbers is by Mr. A. H. Church, with an account of some recent investigations in phyto-chemistry at the laboratory at Cirencester. An analysis of the dried substance of a fungus (*Geoglossum difforme*), and of a lichen (*Collema furvum*), showed the former to contain 19 and the latter as much as 28 per cent. of albuminoids; while the former contains the very large proportion of 13·87, and the latter 6·57 per cent. of ash. Cotton, generally considered to be almost pure cellulose, was analysed with the following result:—

Water	7·56	per cent.
Oil and fat	0·51	,,
Albuminoids	0·50	,,
Gummy matters	0·17	,,
Ash	0·11	,,
Cellulose	91·15	,,
	100·00	

The composition of the pollen of *Cupressus fragrans* was determined as under:—

Carbohydrates and undetermined	85·76	per cent.
Oil and fat	1·87	,,
Albuminoids	8·67	,,
Ash	3·70	,,
	100·00	

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, June 15.—This number contains a paper by Herr Hellmann, of Berlin, on the extension of a short series of observations on temperature by means of the long series of a neighbouring station. It was one of Dove's result's that series of mean temperatures of two neighbouring places derived from a different number of years might be reduced so as to extend over equal periods. His hypothesis has proved a fruitful one. The object of Herr Hellmann was to confirm its value, and this he did by taking mean temperatures already obtained by observation for long and equal periods at two neighbouring places; then assuming that, say for the last five years, no observations had been made at one of them, and calculating from those of the other the required means for the whole period. The difference between the real values and those calculated expresses about the amount of error incurred, which is surprisingly small. Thus, out of eighty-four monthly means for seven pairs of similarly situated stations, only four differences exceeded one-tenth of a degree. But when a hill station is compared with a valley station the agreement is not so good, and it appears that with increase of height the climate becomes more uniform; between an inland and a coast station the difference is still greater, but rarely exceeds half a degree. We may conclude that observations made at a place situated on a plain may safely be employed for the extension of a shorter series of observations made at another place at no great distance, similarly situated, and that the error will be greater when stations different in position are compared.

July 1.—This number contains a review of Mr. Symons's publications on British Rainfall, by M. Raulin, of Bordeaux, and, among the "Kleinere Mittheilungen," a paper on the production of centres of cold in winter.

SOCIETIES AND ACADEMIES

LONDON

Royal Horticultural Society, July 7.—General Meeting.—Hon. and Rev. J. T. Boscawen in the chair.—The Rev. M. J. Berkeley briefly alluded to Mr. Worthington Smith's paper before the Scientific Committee.

July 21.—Scientific Committee.—M. T. Masters, M.D., F.R.S., in the chair—Mr. Bennett exhibited a fine specimen of a fasciated cucumber stem bearing two cucumbers.—Mr. W. G. Smith made a further communication on the resting spores of the potato fungus.—A letter was read from Mr. C. E. Broome, including a sketch of *Diplodia*-like bodies met with in the mycelial filaments.—Mr. Renny made a communication on the same subject, and exhibited a species of *Pythium* (*Saprolegnieæ*), which, without care, might be mistaken for the state of *Peronospora* described by Mr. Smith.—A letter was read from Lady Mathison, accompanying specimens of various larvæ which proved very destructive to the otherwise thriving plantation of Falkland Island Tussock grass (*Dactylis cæspitosa*) in the island of Lewis.—Mr. Alfred Bennett called attention to the rapid growth of the flower-stalk of *Vallisneria spiralis*, which he had observed to grow as much as 12 inches in twenty-four hours.—A letter, communicated by Dr. Hooker, P.R.S., was read from Dr. Imray, of

Dominica, accompanied by an excellent series of specimens of the minute moth (*Cemiostoma coffeella*) which injures the leaves of the coffee plant in Dominica.—Dr Masters exhibited a flower of a hybrid *Tacsonia* in which the anthers were replaced by petals, while from the apex of the tube formed by the filaments, a second corona of blue threads proceeded. Dr. Masters also exhibited a flower of a *Cattleya*, in which there were three equal sepals and four petals all lip-like. From the arrangement of the parts Dr. Masters concluded that there was in this specimen a passage from the whorled to the spiral arrangement.

General Meeting.—Hon. and Rev. J. T. Boscawen in the chair.—The Rev. M. J. Berkeley commented upon the objects exhibited and also upon Mr. W. G. Smith's further observations upon the resting spores of the potato-disease fungus.—Prof. Thiselton Dyer made some observations upon a fine pan of Droseras from the New Forest, exhibited by the Chairman.—Dr. Masters commented on the splendid pitchers of *Nepenthes* sent by Mr. D. Thomson, gardener to the Duke of Buccleugh at Drumlanrig.

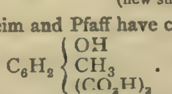
Quekett Microscopical Club, July 23.—Annual Meeting.—Dr. Matthews, president, in the chair.—The report showed that the club had completed the tenth year of its existence and that it continued to make most satisfactory progress; the meetings had been well attended, excellent papers had been read and useful work accomplished, whilst the library and cabinet were in good order, and the field excursions had been very successful. The treasurer's statement showed that the year's income from all sources amounted to 291*l.* 13*s.* 11*d.*, and that there was a balance in hand of 73*l.* 9*s.* 9*d.* Votes of thanks to the president and officers were duly passed, as was also a special vote of thanks to the Council of University College for their continued kindness in allowing the meetings to be held in the library of that building.—The annual address was delivered by the President, and upon its conclusion a ballot took place for the election of officers and committee for the ensuing year. Dr. J. Matthews was re-elected President. Messrs. J. Crisp, R. T. Lewis, B. T. Lowne, and T. C. White, Vice-Presidents. As Hon. Sec., Mr. Ingpen; as Treasurer, Mr. Gay. Hon. Sec. for Foreign Correspondence, Dr. M. C. Cooke. And to fill the four vacancies on Committee, Messrs. M. H. Johnson, F. Oxley, T. Rogers, and Joseph A. Smith.

BERLIN

German Chemical Society, June 28.—A. W. Hofmann, president, in the chair.—Messrs. von Dechen and Wichelhaus have studied the action of nitrobenzole on aniline. They obtain an amorphous violet colouring substance to which they give the formula $(C_6H_4)_3''N_2$; explaining its formation by the equations—

$$1.\ \underset{\text{Nitrobenzole.}}{C_6H_5(NO_2)} + \underset{\text{Aniline.}}{2C_6H_5NH_2} = H_2O + \underset{\text{Violaniline.}}{(C_6H_5)_3N_3}$$

$$2.\ (C_6H_5)_3N_3 = NH_3 + \underset{\text{(new substance).}}{(C_6H_4)_3''N_2}$$

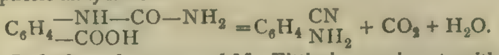
Messrs. Oppenheim and Pfaff have continued their researches on oxyuvitinic acid,  $C_6H_2\left\{\begin{array}{l}OH\\CH_3\\(CO_2H)_2\end{array}\right.$. They have prepared the methylic ether and the first anhydride of this acid, which they have found to be produced not only by the action of chloroform but also by that of chloral, of trichloroacetic ether, and of the chloride of carbon $C\,Cl_4$ on the sodium-compound of acetic ether. They have prepared 150 grammes of pure cresol from this acid and by transforming this cresol into cresotinic acid, methylic and ethylic ethers, methyloxybenzoic, ethyloxybenzoic, and oxybenzoic acids, and studying the properties of these bodies they have determined the cresol obtained to be *metacresol*. This leads them to allege the following position to the lateral groups of oxyuvitinic acid—

$$CH_3 : OH : CO_2H : CO_2H = 1 : 3 : 4 : 6.$$

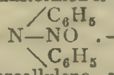
The same chemists have found anisic acid to have the melting-point 184°·2 and methyloxybenzoic acid 106-107°, the melting-points formerly given being 10° too low.—P. Griess has transformed diazocyanobenzol into cyanophenol, by heating its sulphate with water—

$$C_6H_3CN\,N_2 + H_2O = C_6H_4CN\,OH.$$

Hydrochloric acid splits it into ammonia and meta-oxybenzoic acid. The cyananiline necessary for preparing the diazo compound had been prepared by heating uramidobenzoic acid with phosphoric anhydride—



$$C_6H_4\begin{array}{l}-NH-CO-NH_2\\-COOH\end{array} = C_6H_4\begin{array}{l}CN\\NH_2\end{array} + CO_2 + H_2O.$$

—A. Ladenburg has repeated Mr. Fittica's experiments without obtaining a trace of his presumed and inexplicable isomers of Nitrobenzoic acid.—O. Witt, by treating diphenylamine with nitrous ether has transformed it into yellow brilliant crystals of diphenyl-nitrosamine  $N\begin{array}{l}\diagup C_6H_5\\-NO\\\diagdown C_6H_5\end{array}$.—A Pinner has transformed $C_3H_2Cl_2$ into a nitrochloroallylene, which, with tin and hydrochloric acid yields $C_3H_4Cl_3NH_2$ trichloropropylamine. Sodium acts on $C_3H_2Cl_2$ in a peculiar way. It forms with it a solid compound decomposed by water into chloride of sodium and C_3H_2 a gas forming the bromide $C_3H_2Br_2$.—A. W. Hofmann has distilled the compound ammonium $(CH_3)_3NC_2H_3OH$, hoping to obtain vinylic alcohol; he obtained, however, trimethylamine, water, and acetylene.

PARIS

Academy of Natural Sciences, July 26.—M. Fremy in the chair. The following papers were read:—Researches on the theory of aberration, and considerations on the influence of the proper motion of the solar system in the phenomenon of aberration, by M. Yvon Villarceau.—On the latitude of Abbadia near Hendaye (Basses Pyrenees), by M. A. D'Abbadie.—On the distribution of magnetism in compound bundles of very thin bars of finite length, by M. J. Jamin.—Note by M. Chevreul on the Compte Rendu of the meeting of July 19.—Complementary notice on the contemporaneous formation of minerals by the thermal springs of Bourbonne-les-Bains (Haute Marne); production of phosgenite, by M. Daubrée.—Researches on the phenomena produced by electric currents of high tension, and their analogy with natural phenomena, by M. G. Planté.—Action of electrolytic oxygen on glycerine, by M. Ad. Renard. The author finds as the result of this action formic and acetic acids and the first glyceric aldehyde.—Study of the pyrites employed in France for the manufacture of sulphuric acid, by MM. A. Girard and H. Morin.—On the toxic properties of the fermentation alcohols, by MM. Dujardin-Beaumetz and Audigé.—On amyloxanthate of potassium (for the destruction of Phylloxera), by MM. Zoeller and Grete.—On the thermal phenomenon accompanying inversion, by M. G. Fleury. The author concludes that the inversion of sugar by acids is an exothermal phenomenon.—Note on a substance serving to adulterate guanos, by M. F. Jean.—New researches on germination, by M. P. P. Dehérain.—Experiments showing that the mammæ removed from young female guinea pigs are not reproduced, by M. J. M. Philipeaux.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—British Wild Flowers. Parts 14 and 15: J. E. Sowerby (Van Voorst).—Sound. New Edition: J Tyndall, D.C.L., LL.D., F.R.S. (Longmans).—Six Lectures on Light, delivered in America, 1872–73. New Edition: J. Tyndall, D.C.L., LL.D., F.R.S. (Longmans).—Geometrical Contributoins to the *Educational Times*: T. Archer Hirst, F.R.S. (Hodgson and Son).—Report of the Inspectors of Irish Fisheries for 1874 (Dublin, Thom).—Insectivorous Plants: Charles Darwin, M.A., F.R.S. (John Murray).

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THURSDAY, AUGUST 12, 1875

THE SCIENCE COMMISSION REPORT ON THE ADVANCEMENT OF SCIENCE

SINCE our last week's issue two Reports of the above Commission have been issued, one of them, the Eighth and Final Report, dealing especially with the Advancement of Science.

We attach so much importance to this branch of the inquiry entrusted to the Commission, that we shall deal with the Eighth Report first; and as the Recommendations which the Commission make and the Considerations which have led up to them have long been anxiously looked for, we shall defer any remarks of our own this week, in order to give the Considerations and Recommendations *in extenso*. The following are the various branches into which the Report is divided :—

1. The Scientific Work carried on by Departments of the Government.
2. The Assistance at present given by the State towards the promotion of Scientific Research.
3. The Assistance which it is desirable the State should give towards that object.
4. The Central Organisation which is best calculated to enable the Government to determine its action in all questions affecting Science.

The general remarks made by the Commission on the evidence adduced on the first three heads are as follows :—

"The great advances in physical science which have been made in this country, and within this century, by such men as Dalton, Davy, and Faraday, without aid from the State; the existence of our numerous learned societies, and the devotion of some few rich individuals to the current work of science, at first sight appear to reduce the limits within which State aid to research is required in this country.

"But whilst we have reason to be proud of the contributions of some great Englishmen to our knowledge of the laws of nature, it must be admitted that at the present day scientific investigation is carried on abroad to an extent and with a completeness of organisation to which this country can offer no parallel. The work done in this country by private individuals, although of great value, is small when compared with that which is needed in the interests of science; and the efforts of the learned societies, not excepting the Royal Society, are directed to the discussion and publication of the scientific facts brought under their notice; these societies do not consider it any part of their corporate functions to undertake or conduct research.

"It will have been seen, from the extracts from the evidence, that amongst the witnesses who have advocated an increase of State assistance are some who have made great sacrifices in time and money in the cause of scientific research.

"But whatever may be the disposition of individuals to conduct researches at their own cost, the advancement of modern science requires investigations and observations extending over areas so large and periods so long that the means and lives of nations are alone commensurate with them.

"Hence the progress of scientific research must in a great degree depend upon the aid of Governments. As a nation we ought to take a share of the current scientific work of the world; much of this work has always been voluntarily undertaken by individuals, and it is not desirable that Government should supersede such efforts; but it is bound to assume that large portion of the national duty which individuals do not attempt to perform, or cannot satisfactorily accomplish.

"The following considerations have been suggested to us by the heads of evidence relating to (1) Laboratories, (2) Observatories, (3) Meteorology, (4) Tidal Observations, and (5) the Payment of scientific workers.

"1. The first condition of scientific investigation is that there should be collections, laboratories, and observatories accessible to qualified persons. The evidence has shown that at present, for certain branches, these do not exist or are incomplete.

"Moreover, there can be no doubt that the Government service should, to a great extent, contain within itself the means of carrying on investigations specially connected with the departments. Even having regard only to the current wants of the State, additional appliances are necessary.

"Three distinct ways have been suggested in which the State might assist in providing the aids to investigation which are required by private individuals. It has been proposed: first, that competent investigators should receive grants in money enabling them to provide themselves with means for conducting their researches; secondly, that laboratories, designed primarily for the service of the State, and those of Universities and other similar institutions receiving aid from the State, should be placed, under proper conditions, at the disposal of such inquirers; thirdly, that laboratories should be erected by the Government specially designed for the use of private investigators, though of course also available for the service of the State. Wherever the first of these methods can be conveniently and economically adopted, we are disposed to consider that it is the simplest and the best; but it must be remembered that for many researches apparatus of a costly but durable character are among the primary requisites; and that to provide these separately for each investigator would involve a large and unnecessary expenditure. It appears to us that the difficulty thus arising might be adequately met by the adoption of the second of the above suggestions. Our attention has, indeed, been called to the inconveniences which might arise from the admission of independent workers into University or State laboratories. But, notwithstanding this difficulty, we think the experiment is one which ought to be tried, and till it has been tried we should hesitate to recommend the erection by the State, for the especial use of private investigators, of laboratories which would certainly be costly, and might possibly be only imperfectly utilised.

"2. Upon a review of the whole of the evidence relating to the subject of Astronomical Physics, we are of opinion that an observatory for that branch of science should be established by the State. In the study of Solar Physics, continuity of the observations is of the greatest importance; and owing to our variable climate, continuous observations of the sun in this country are subject to peculiar difficulties which should be duly considered in the site for such an observatory. The neighbourhood of London is less favourable to physical observations than many other sites which might be found, and for this reason we should prefer that a physical observatory should be placed elsewhere than at Greenwich. On other grounds, also, we think that the Observatory for Astronomical Physics should be an institution entirely distinct from any of the national observatories for Mathematical Astronomy. The subject of Mathematical Astronomy is vast enough to occupy adequately the whole energies of a director, and it is especially important that Astronomical Physics should have the undivided attention of the head of an observatory, because its methods, which are of very recent invention, are as yet incompletely developed, and because, depending, as they do, on a continual comparison of celestial phenomena with the results of experiments in the laboratory, they are entirely different from those of Mathematical Astronomy.

"Our opinion as to the desirability of such an institution is confirmed by the example of foreign nations; observatories for astronomical physics being already at work in various parts of Italy, and their immediate erection having been determined on at Berlin and at Paris.

"We venture to express the hope that similar institutions may before long be established in various parts of the British Empire. The regularity of the climatic conditions of India, and the possibility of obtaining there favourable stations at considerable heights, render it especially desirable that arrangements should be made for carrying on physical observations of the sun in that country.

"3. With respect to Meteorology we are of opinion that the operations of the Meteorological Office have been attended with great advantage to science and to the country. The subject of Meteorology is a very vast one, and any scheme for its proper cultivation or extension must comprise—(1) Arrangements for observing and registering meteorological facts; (2) Arrangements for the reduction, discussion, and publication of the observations; (3) Researches undertaken for the purpose of discovering the physical causes of the phenomena observed. The resources placed at the disposal of the Committee are inadequate to cover the whole of this wide field; and, having due regard to all the circumstances of the case, we believe that in selecting certain parts of it, as the objects of their special attention, they have been guided by a sound discretion.

"We are also disposed to consider that although, as we have already said, the Meteorological Committee occupies an anomalous position, no other form of organisation could advantageously have been adopted under the actual conditions. We think, however, that if, as we shall hereinafter recommend, a Ministry of Science should be established, the head of the Meteorological Office should be made responsible to the Minister. We fully concur with the opinion expressed by the witnesses that many branches of meteorology can only be effectually promoted by an organisation having the support of Government; and we would draw especial attention to the consideration that if meteorology is to take rank as a branch of terrestrial physics, the observations must be made at stations widely dispersed over all parts of the earth's surface, and those taken by observers of different nations must be so arranged as to be comparable with one another. It is obvious that the intervention of Government would greatly facilitate the attainment of both these objects.

"We are very unwilling that any scientific observations which can adequately be carried on by individuals or associations of individuals, should be undertaken by a department of the Government. So far as the local interests connected with climatic meteorology suffice to ensure due attention being paid to that branch of science, we should prefer to see it left mainly to scientific societies, any assistance the Government might afford being merely subsidiary. That useful results may be obtained by voluntary effort is evident from the work carried on under the direction of Mr. Glaisher, and from the case of the Scottish Meteorological Society, which has succeeded, with very narrow means, in organising a valuable system of observations on the meteorology of Scotland. It is, however, important that any grants for the promotion of meteorological observations in aid of voluntary efforts should be made on some systematic principle; and the attainment of this object would be furthered by making them subject to the control of a minister, who would be cognisant of all the facts relating to the expenditure of the Government upon meteorology.

"We may point out that the returns furnished by the Scottish Meteorological Society and Mr. Glaisher, are adopted by the Registrars General, and are recognised by Committees of Parliament in discussions affecting the public health, the supply of water, and other matters of the same kind. The value of observations undertaken, as in this case, by private individuals or voluntary associations, must vary from time to time, according to the efficiency of the persons principally concerned in their superintendence. We feel, therefore, that the question how far it is proper that such observations should receive official sanction, cannot be decided *a priori*, and must be left to the judgment of the responsible Minister for the time being.

"4. With regard to tidal observations, it will be seen that, in the opinion of the witnesses, these have not hitherto been conducted and reduced systematically. Considering the agencies which the Government can employ for the purpose of making these observations, the importance of providing proper superintendence for them, and of securing their reduction, we think it desirable that they should be carried on under Government control. The expense involved would chiefly consist in the establishment at proper points, and verification, of tide gauges, and in the reduction of the observations; these being entrusted to officers of Government already stationed at the ports and on the various coasts of the Empire.

"5. The witnesses have expressed themselves strongly as to the justice and policy of remuneration to investigators for their time and trouble, and the evidence also shows by implication how great must have been the sacrifices of those who without private fortune have hitherto devoted their great talents and their valuable time to such work without any remuneration whatever.

"It has hitherto been a rule in the granting of Government aid to scientific investigators, subject, so far as we have been able to ascertain, to but very few exceptions, that such aid should be limited to what was necessary to meet the expenditure actually incurred on instruments, materials, and assistance.

"To grants made under these conditions we think that considerable extension might be given.

"It is hardly necessary to assert the principle that when scientific work is undertaken at the request of the Government, the State is not only justified in paying, but is under obligation to pay for what is done on its behalf and for its service. But we desire to express our belief that there are many instances of unremunerative research in which the benefit conferred on the nation by those who have voluntarily engaged in it establishes a claim upon the State for compensation for their time and labour. Without such compensation much important work must remain unperformed, because it must be expected that many of the best men will not be in circumstances enabling them to devote long periods of time to unremunerated labour.

"It is a matter of course that State aid shall only be given to investigators whose capacity and industry have been placed beyond a reasonable doubt."

With regard to head IV., the Commissioners make the following general remarks:—

"The functions of the Government with regard to science may be summed up under the three following heads:—

"1. The treatment of the scientific questions incident to the business of the public departments.

"2. The direction of scientific instruction when given under the superintendence or control of the State.

"3. The consideration of all questions involving State aid towards the advancement of science, and of administrative questions arising out of such aid.

"It would be difficult to enumerate exhaustively all the various topics comprehended under these three heads, and it will be sufficient for the purpose of showing how wide is the field of action of the State in regard to science, if we point out that under one or other of these heads are included all scientific questions affecting the army, the navy, the public health, the mercantile marine, public works, Government scientific establishments; the elementary instruction in science under the department of education in primary schools, in the science classes connected with the Science and Art Department, and in secondary schools so far as they are subject to Government control; the aid which is now given, or which it is desirable should be given, to universities and other bodies not directly connected with the State, for the middle and higher scientific instruction, and the control which the State either does or should exercise over them in virtue of such aid or otherwise; the appointments to all scientific offices in the gift of the Crown; grants to museums and their control by the State; aid to scientific expeditions of every kind; the establishment and direction of State laboratories and observatories; grants in aid of such laboratories not under State direction, and in aid of scientific research; and generally the allotment and control of public funds for similar purposes.

"The majority of the witnesses who have given evidence in relation to this branch of the inquiry, express dissatisfaction with the manner in which questions under the preceding heads are now determined, and either recommend the appointment of a special minister of science or of a minister of science and education.

"In most cases the witnesses recommend that such a minister should, in regard to science, be advised by a council. Others, however, are of opinion that the functions of such a council might be exercised by an administrative staff of the usual kind."

After adducing a mass of evidence with regard to this subject, the establishment of a Ministry and Council of Science, the Commission thus discusses it:—

"We have given careful consideration to this part of the Inquiry entrusted to us; and, in the course of our deliberations we have been led to attach much importance to the facts stated in the first part of our report, which show that the scientific work of the Government is at present carried on by many different departments.

"There is nothing to prevent analogous, if not actually identical, investigations being made in each of these, or to secure to one department an adequate knowledge of the results obtained, and the circumstances under which they were obtained, by another.

"Investigations admitted to be desirable, nay, practical questions, the solution of which is of the greatest importance to the public administration, are stated by the witnesses to be set aside because there is no recognised machinery for dealing with them; while, in other cases, investigations are conducted in such a manner as to involve a needless outlay of time and money, because they were originally planned without consultation with competent men of science.

"Passing to the question of the advancement of science, we have arrived at the conclusion that much has to be done which will require continuous efforts on the part of the administration unless we are content to fall behind other nations in the encouragement which we give to pure science, and, as a consequence, to incur the danger of losing our pre-eminence in regard to its applications.

"These considerations, together with others which have come before us in the course of our inquiry, have impressed upon us the conviction that the creation of a special Ministry dealing with science and with education is a necessity of the public service.

"This Ministry would be occupied (1) with all questions relating to scientific and general education, so far as these come under the notice of government; (2) with all questions incidental to the application of national funds for the advancement of science; and (3) with all scientific problems in the solution of which the other departments may desire external scientific advice or information. It would also be desirable that the department should receive information as to scientific investigation proposed by other branches of the Government, and record their progress and results.

"It is not within our province to express an opinion as to whether the subject of art should be included among the functions of this department; but we are satisfied that the Minister's attention should not be distracted by any immediate responsibility for affairs which have no connection with science, education, or art.

"We have considered whether the official staff of such a Ministry, however carefully selected, could be expected to deal satisfactorily with all the varied and complicated questions which would come before the department. We have given full weight to the objections which have been raised against the creation of a special council of science, and to the arguments in favour of referring scientific questions to learned societies, or to special committees appointed for the purpose, or to private individuals; but nevertheless we have arrived at the conclusion that an additional organisation is required through which the Minister of Science may obtain advice on questions involving scientific considerations, whether arising in his own department or referred to him by other departments of the Government.

"Such questions have from time to time been referred to the Council of the Royal Society, in which the best scientific knowledge of the time is fairly represented. The Committee chosen by that Council for the administration of the government grant of 1,000*l.* per annum in aid of scientific investigations has performed its work to the satisfaction of the Government, of men of science, and of the public. But if much more is to be done for the advancement of science than at present, and if the Departments in conducting their investigations are to have the benefit of the scientific advice which appears now to be frequently wanting, the Council of the Royal Society, chosen as it is for other purposes, could scarcely be expected to take upon itself functions which, it is true, are not different in kind, but which would involve increased responsibility and the expenditure of additional time and trouble. Moreover, amongst the questions on which the departments would require scientific advice, there would no doubt be many requiring a knowledge of the peculiar exigencies of the public service, which would be more readily understood and solved if some persons in direct relation with the departments formed a part of the body to be consulted. It is obviously of great importance that the council should be so constituted as to possess the confidence of the scientific world, and we believe that this confidence would be extended to a council composed of men of science selected by the Council of the Royal Society, together with representatives of other important scientific societies in the United Kingdom, and a certain number of persons nominated by the Government. We also believe that such a body would deserve and receive the confidence of the Government, and that it would be well qualified to administer grants for the promotion of pure science.

"The general opinion we have expressed as to the proper remuneration of scientific work would be applicable to the members of this Council, but the degree and manner in which the principle should be applied in this instance must be so largely dependent on circumstances that we cannot make any specific recommendation on the subject.

"It would be impossible that the Council should in all cases undertake the direct solution, by itself or even by sub-committees, of the problems submitted to it. In many instances, especially when experimental investigations are required, its duty would be accurately to define the problem to be solved, and to advise the Minister as to the proper persons to be charged with the investigation.

"We are of opinion that the Council should not have the power of initiating investigations; it should, however, not be precluded, in exceptional cases, from offering to the Minister such suggestions as it may have occasion to make in the public interest.

"We believe that reference to such a council would be found to be so useful and convenient that it would become the usual course in cases of difficulty, but we would not diminish the responsibility or fetter the discretion of any Minister by making such reference obligatory, or by preventing a reference to committees or to individuals chosen by him, whenever that course might appear to him to be more desirable.

Finally the Report concludes with the following "Conclusions and Recommendations":—

"I. The assistance given by the State for the promotion of scientific research is inadequate, and it does not appear that the concession or refusal of assistance takes place upon sufficiently well-defined principles.

"II. More complete means are urgently required for scientific investigations in connection with certain Government departments; and physical as well as other Laboratories and apparatus for such investigations ought to be provided.

"III. Important classes of phenomena relating to Physical Meteorology, and to Terrestrial and Astronomical Physics, require observations of such a character that they cannot be advantageously carried on otherwise than under the direction of the Government.

"Institutions for the study of such phenomena should be maintained by the Government; and, in particular, an observatory should be founded specially devoted to Astronomical Physics, and an organisation should be established for the more complete observation of tidal phenomena and for the reduction of the observations.

"IV. We have stated in a previous Report that the national collections of Natural History are accessible to private investigators, and that it is desirable that they should be made still more useful for purposes of research than they are at present. We would now express the opinion that corresponding aid ought to be afforded to persons engaged in important physical and chemical investigations; and that whenever practicable such persons should be allowed access, under proper limitations, to such laboratories as may be established or aided by the State.

"V. It has been the practice to restrict grants of money made to private investigators for purposes of research to the expenditure actually incurred by them. We think that such grants might be considerably increased. We are also of opinion that the restriction to which we have referred, however desirable as a general rule, should not be maintained in all cases, but that, under certain circumstances and with proper safeguards, investigators should be remunerated for their time and labour.

"VI. The grant of 1,000*l.*, administered by the Royal Society, has contributed greatly to the promotion of research, and the amount of this grant may with advantage be considerably increased.

"In the case of researches which involve, and are of sufficient importance to deserve, exceptional expenditure, direct grants in addition to the annual grant made to the Royal Society, should be made in aid of the investigations.

"VII. The proper allocation of funds for research; the establishment and extension of laboratories and observatories; and, generally, the advancement of science and the promotion of scientific instruction as an essential part of public education, would be most effectually dealt with by a ministry of science and education. And we consider the creation of such a ministry to be of primary importance.

"VIII. The various departments of the Government have from time to time referred scientific questions to the Council of the Royal Society for its advice; and we believe that the work of a minister of science, even if aided by a well-organised scientific staff, and also the work of the other departments, would be materially assisted if they were able to obtain, in all cases of exceptional importance or difficulty, the advice of a council representing the scientific knowledge of the nation.

"This council should represent the chief scientific bodies in the United Kingdom. With this view its composition need not differ very greatly from that of the present Government Grant Committee of the Royal Society. It might consist of men of science selected by the Council of the Royal Society, together with representatives of other important scientific societies, and a certain number of persons nominated by the Government. We think that the functions at present exercised by the Government Grant Committee might be advantageously transferred to the proposed Council."

HINRICHS' "PRINCIPLES OF CHEMISTRY"

The Principles of Chemistry and Molecular Mechanics. By Dr. Gustavus Hinrichs, Professor of Physical Science in the State University of Iowa. (Davenport, Iowa, U.S.: Day, Egbert, and Fidlar, 1874.)

THIS work constitutes the second volume of a treatise on "The Principles of the Physical Sciences," and its main object is to present theoretical chemistry in its most modern aspect and to discuss its laws from a dynamical point of view. It is divided into two portions: "Molecular Statics," and "Molecular Dynamics." The former commences with an account of chemical atoms, it being premised that the conception of a chemical atom is the basis of the modern chemical theory. Although the author tells us that the chemical atom is a reality, while the philosophic atom is only a possibility, we have a little difficulty in accepting his definition of a chemical atom as "a very minute, relatively indivisible particle of matter." For it is surely unwise to retain a term so precise in its etymological significance if we admit its divisibility. We are told that "an atom of lead sulphide" can be divided into an atom of lead and an atom of sulphur; and further (p. 19), that "the molecule of gaseous compounds consists of one atom of the compound." But a molecule is defined as a "group of atoms" elsewhere, so that it would appear that a molecule is sometimes an atom, and an atom is sometimes a molecule, and such confusion of ideas must be most detrimental to the acquirement of exact knowledge by the student.

It is useless for us to protest against variations in the mode of writing formulæ, for such protestations have been made any time during the last ten years in vain; but we are quite justified in saying that such changes harass the student to an extent to which the authors of them can scarcely be aware. Why should $NaCl$ be written $NaCl^{ide}$, and $KaNO_3$, KaN^{ate}, and so with all sulphates, oxalates, nitrates, and a host of other salts? And why, when the almost universal custom is to write sulphates as MSO_4, and nitrates as MNO_3, does our author write MO_4S and MO_3N?

We are glad to notice the introduction of the recent surmises as to the absolute weight of atoms, although at present we believe that such ideas cannot be of much real use to the student. We are told that a milligram of hydrogen contains about 400,000000,000000,000000 atoms of hydrogen, and a milligram of gold 2,000000,000000,000000 atoms, while the atomic weight of gold is given as 196; if this is admitted, the milligram of gold will contain some 40816,000000,000000 atoms in excess of the number given above, and the omission of this will in itself show the extreme generality of such statements. A curious deduction as to the *form* of atoms is drawn from the fact that many minerals are observed, when reduced to powder, to preserve their normal crystalline form; hence, says our author, "we conclude the compound atom possesses form closely related to the cleavage form."

The law of Dulong and Petit is very concisely stated, and its importance in modern chemistry is well illustrated. It is crudely formulated thus:—if a represents the atomic weight and s the specific heat, the product $a\,s$ will be the specific heat S of a gram-atom of the substance, and $S = a\,s$ nearly equal to 6·3.

Or again, if the specific heat S of an element be known, an approximate determination of the atomic weight can be found as follows:—

$$a = \text{nearly } \frac{6\cdot 3}{s}$$

Thus the specific heat of lead = 0·031, consequently $\frac{6\cdot 3}{\cdot 031} = 200$, the exact atomic weight of lead being 207. The service afforded by the application of this law to the determination of the *right* atomic weight of an element is also shown in this case of lead, for from the analysis of oxide of lead the atomic weight of lead might be 207, or 103.5, or 69, or 414, or 621, for although we find that sixteen parts by weight of oxygen are united with 207 of lead, we have no direct chemical proof that the 207 represents one atom; but the law of Dulong and Petit now steps in and shows us that the right atomic weight is 207, because it alone satisfies the conditions of that law. And so for other elements the vapour density of whose compounds cannot be determined. The section on Atomicity or valence would be much improved by the introduction of a complete list of the elements with their atomicities, and a discussion of doubtful atomicities.

In the seventh section the author passes at once from what were once called inorganic compounds to the discussion of organic substitutions as shown in the great methyl series of compounds. Such comprehensive statements as, "the binary marsh gas, also called *methane*, CH_4, is the basis of all organic compounds," are of great use to the student, and in this instance the statement at once justifies the passage from mineral chemistry to so-called organic chemistry without one word of introduction or comment. We do not think that the attempted graphical representation of chemical constitution in the eighth section can be productive of anything but confusion to the student. The crosses and dots and three-limbed signs have themselves to be remembered, and cannot give any precise idea of the constitution of a complex compound. A somewhat detailed account of the constitution and syntheses of various serial compounds concludes that portion of the work devoted to Molecular Statics.

The second part commences with an account of the motions of molecules, and it is asserted that since molecules are not spherical, their impact against each other will not alone produce motion of translation, but also motion of rotation, and this is partially illustrated by the motion of a boomerang. The following definitions are stated on the authority of the author:—

1. "The molecules of a body in the gaseous condition have a motion of translation, and also a motion of rotation around their natural axis of maximum moment of inertia."

2. "The molecules of a body when in the solid state have only a vibratory motion about a position of equilibrium."

3. "The molecules of a body when in the liquid state have a vibratory motion, as in the solid state, and also a motion of rotation around their natural axis of minimum moment of inertia."

Among the concluding sections of the book is a very interesting and suggestive account of *caloration*, that is the amount of heat produced or absorbed in any chemical process. The treatment (p. 153), from a caloration point of view, of the reactions of hydrogen, chlorine, iodine, and silver, is worthy of careful study. A few pages at the end of the book treat of Systematic Chemistry and Applied Chemistry.

Dr. Hinrich's book must be used in connection with his former works, "Elements of Chemistry" and "Elements of Physics," to which frequent references are made. It is mainly intended as a guide to the student, and must be used with the assistance of a teacher. To the advanced student it will be found to be of great use, and most eminently suggestive; but it will be almost useless to any reader who has not before acquired the main principles of chemical science, together with a large storehouse of chemical facts. The work is somewhat disfigured by numerous misprints—*dissociotion* (p. 21), *amides* (p. 73), *reductian* (p. 109), *enery* (p. 113), &c., and we think the two plates at the end are extremely confusing; but these minor matters are easily remedied in a second edition, and need not detract greatly from the value of a really useful and comprehensive work.

G. F. RODWELL

THE ZOOLOGY OF THE "EREBUS" AND "TERROR."

The Zoology of the Voyage of H.M.S. "Erebus" and "Terror," under the command of Captain Sir James Clark Ross, R.N., F.R.S., during the years 1839 *to* 1843. By authority of the Lords Commissioners of the Admiralty. Edited by John Richardson, M.D., F.R.S., &c., and John Edward Gray, Esq., Ph.D. F.R.S., &c.

No. XIX.—*Insects* (conclusion). By Arthur Gardiner Butler, F.L.S., F.Z.S., &c. 1874.

No. XX.—*Crustacea.* By Edward J. Miers. 1874.

No. XXI.—*Mollusca.* By Edgar A. Smith, F.Z.S., &c.

No. XXII.—*Birds* (conclusion). By R. Bowdler Sharpe, F.L.S., F.Z.S., &c. 1875.

No. XXIII.—*Mammalia* (conclusion). By John Edward Gray, Ph.D., F.R.S., F.L.S., &c. 1875.

No. XXIV.—*Reptiles* (conclusion). By Albert Günther, M.A., M.D., Ph.D., F.R.S., V.P.Z.S. 1875.

THE non-completion of the "Zoology of the Voyage of the *Erebus* and *Terror*" has long been a public scandal. The celebrated voyage of these ships, commonly known as the "Antarctic Expedition," took place in 1839, and the four following years. Dr. Hooker, under the title of "Assistant Surgeon" to the *Erebus*, was the Naturalist of the Expedition, and assisted by Messrs. M'Cormack and Robertson, the medical officers of the vessels, made an extensive collection of specimens in every department of zoology and botany. The botanical specimens were sent to Kew; the zoological to the British Museum. Dr. Hooker undertook the working out and publication of the former, and Dr. Gray of the latter. At the recommendation of the Admiralty the Government granted the sum of 2,000*l.* for the illustration of the work, half of which was assigned to the botanical and half to the zoological portion. Dr. Hooker's labours resulted in the two large quarto volumes which form the well-known "Botany of the Antarctic Expedition," and remain to the present day the standard authority upon the plants of the southern hemisphere. Very different were the results achieved by the thousand pounds bestowed upon the zoological portion of the work. After the publication of eighteen numbers, the various sections assigned to the different naturalists were left, one and all, incomplete, and have thus remained until the present day. Whether this untoward result was occasioned by the fault of the editor or of the publisher, or by misunderstandings between the two, has never been divulged to the public, nor does it now much concern us to inquire. Whichever may have been the case, the result was equally discreditable to the parties concerned. It is with pleasure, however, we see that the scandal exists no longer. An enterprising publisher has bought up the "remainder" of the plates of the unfinished work, and made arrangements for its completion. Whether it was justifiable on the part of the vendor to sell what had been produced by public money may be open to some doubt, but the purchaser, Mr. Janssen, is at all events entitled to the credit of having done all he could to bring this long neglected work to a satisfactory conclusion. The six numbers of the "Zoology of the *Erebus* and *Terror*" now before us, conclude the different sections, and enable the subscribers after twenty years of patient expectation to send their copies to the binders. On turning over the pages of the lately issued numbers, we find many admirably executed plates among them, and much valuable contribution to Zoological science. Dr. Günther's synopsis of the Australian Lizards is of special interest, and will, we are sure, prove most acceptable to the working naturalists of the Australian Colonies. As regards some of the illustrations of the birds, we may remark that the colouring is not very well executed—notice especially the figures of the King and Emperor Penguins. This is the more the pity, as the figures themselves are the productions of Mr. Wolf's artistic pencil.

OUR BOOK SHELF

Flora of Eastbourne. Being an Introduction to the Flowering Plants, Ferns, &c., of the Cuckmere District, East Sussex, with a Map, by F. C. S. Roper, F.L.S., &c., President of the Eastbourne Natural History Society. 8vo, pp. 165. (London, Van Voorst.)

THIS is an admirable little book of its kind, the greatest care and conscientiousness having evidently been exercised in its compilation. The plan adopted by the author was to include only such species as he had actually gathered himself, or of which he had seen authentic specimens, hence a considerable number of species which we know, from personal observation, to grow within the limits of the Cuckmere district are omitted, or only given in an appendix. However, Mr. Roper will doubtless soon publish a supplement, and the basis upon which he has started is far preferable to the indiscriminate admission of everything from sources of uncertain value. Another cause for the absence of certain species is the quite recent extension of the field of operations to coincide with the Cuckmere drainage district of Mr. Hemsley's projected flora of the whole county. This forms an irregular triangle, having its apex on the ridge of the weald at Cross-in-hand, and its base running along the coast from the Signal House, east of Seaford, to St. Leonards. Its area is about 150 square miles, and it comprises a great variety of soils and situations, but there is very little boggy land, consequently a paucity of bog plants. Mr. Roper's list numbers 700 species, which further explorations will probably augment by about one hundred. It is surprising that such plants as *Papaver dubium*, *Arenaria trinervis*, *Rubus discolor*, *Campanula rotundifolia*, *Ophrys muscifera*, *Juncus maritimus*, *Aira flexuosa*, *Bromus giganteus*, &c., should have escaped observation; but such is the case, and they are not included in the *Flora*. Among the more interesting plants of this part of Sussex, and not found elsewhere in the county, we may mention *Phyteuma spicatum*, *Pyrola minor*, *Bupleurum aristatum*, *Seseli Libanotis*, *Sibthorpia europæa*, and *Bartsia viscosa*. The *Pyrola* was recently discovered in Sussex for the first time by Mr. Roper, so the botanist should never despair of finding something new. The *Flora of Eastbourne* has appeared just at the right time for visitors to Eastbourne this season, who will find it a valuable guide, and all the more welcome, perhaps, because there is a chance of adding to the number of species it includes. We should add that, like most local floras of recent publication, it simply treats of the distribution of the plants, but the book before us differs from most others in its copious references to other works, which will be useful to amateurs who may have occasion to consult descriptions or plates.

We may here mention that we have received a circular from the Lewes and East Sussex Natural History Society respecting a projected Fauna and Flora of East Sussex, which will be forwarded to any person interested in the work on application to the Secretary, Mr. J. H. A. Jenner, Lewes.

Repertorium der Naturwissenschaften. Monatliche Uebersicht der neuesten Arbeiten auf dem Gebiete der Naturwissenschaften. Herausgegeben von der Redaction des *Naturforscher*. (January to June 1875, Nos. 1 to 6, Berlin.)

THIS is a useful supplementary publication to *Der Naturforscher*. It consists of sixteen columns (the columns are numbered and not the pages) in quarto form. The number for May is made up of twenty-four columns, and gives the titles of more than 600 papers, which are published in upwards of eighty separate works. The periodicals thus indexed are the *Monatsberichte* (Berlin), *Comptes Rendus* (Paris), *Botanische Zeitung* (Leipzig), *Flora* (Regensburg), *Hedwigia* (Dresden), *Proceedings of the Royal Society* (London), *American Journal of Sciences and Arts* (New Haven), *Geographical Magazine* (London), *Messenger of Mathematics*, *Astronomische Nachrichten* (Kiel), &c. Though there are several publications we miss, both English and foreign, it will be seen that a good beginning is here made, and that there is a prospect in time of students being fairly informed of what is being done in science in this country and elsewhere in a compact publication issued at a reasonable rate.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Properties of Selenium

In a letter headed "Anomalous behaviour of Selenium," which appeared in Nature (vol. xii., p. 187), Mr. Gordon states that "it has lately been observed that the electrical resistance of selenium is greater in light than in the dark." I am anxious to learn where an account of this remarkable observation is to be found.

Mr. Gordon afterwards announces the discovery that a bar of granular selenium belonging to the Cavendish Laboratory exhibits a decrease of resistance under the influence of light. This phenomenon was well-known outside the Cavendish Laboratory more than two years ago. Mr. Gordon also states that the very high resistance of a certain medal of selenium did not sensibly alter under the influence of light; and concludes that "the physical form of the metal" seems to have some influence on its electrical properties. From his description of the medal it would appear that it is made of vitreous selenium. I am therefore surprised that its resistance was so low. A conducting form of selenium having the appearance of black-lead is certainly a novelty.

It is perhaps not generally known that the electrical properties of selenium are very variable. In a paper by Mr. Henry Draper and myself which appeared in the "Proceedings of the Royal Irish Academy" (vol. i. ser. ii. (Sci.) p. 529), we have shown that there is a granular variety of the element which is, at ordinary temperatures, apparently as good a non-conductor as the vitreous variety. Unlike the latter, however, it cannot be rendered electrical by friction. Another granular modification of the element was found to conduct electricity comparatively well in darkness, and scarcely any better under the influence of light; while there is an intermediate state of the element which appears to possess a molecular structure so susceptible of change, that light is capable of converting it temporarily into the form which conducts comparatively well. Some bars which we prepared of this sensitive variety exhibited an increased conductivity of 100 per cent. under the influence of sun-light. In appearance there is not the slightest difference between this and the non-conducting granular variety, both exhibiting a gray granular fracture resembling that of the metal cobalt. In the course of our experiments Mr. Draper and I prepared a large number of bars and plates of various shapes and sizes, but we have not observed any unusual connection between the shape of the bars or plates and their resistance. There is a great difficulty in making observations with reference to this point, as we are as yet unable to produce two or more bars of the sensitive variety possessing the same electrical properties. Thin plates are generally more sensitive to light than cylindrical bars, but we have occasionally prepared bars as sensitive in proportion as a plate measuring 75 × 15 mm., and only 0·5 mm. in thickness.

I have not as yet been able to learn the contents of Prof. Adams's recent paper on this subject, but Mr. Gordon says that he has shown that the phenomenon is a purely optical one. I may state that Mr. Draper and I have long since shown that, so far as the effect of heat on electrical resistance is concerned, some forms of granular selenium conform to the metallic type. This was demonstrated by placing a plate of selenium inside a spiral of platinum, at a distance of about 4 mm. from the wire. The usual decrease of resistance took place when the plate was exposed to light; but on heating the surrounding platinum wire by passing a current of electricity through it, the resistance of the selenium increased considerably. The effect of light is therefore partially counterbalanced by the effect of the heat which usually accompanies it. This partly explains the increase of resistance that is known to follow prolonged exposure to light. A portion of this increase being doubtless due to the slight elevation of temperature that must result from the passage of the current through the selenium. The opposite action of light and heat is very remarkable, especially as the longest light undulations are those that cause the greatest decrease of resistance. It is remarkable, also, that a thin film of non-conducting vitreous selenium transmits these red rays, while an equally thin film of granular selenium is perfectly opaque to them.

Richard J. Moss

Mr. Darwin and Prof. Dana on the Influence of Volcanic Action in preventing the growth of Corals

In his critique on the new edition of Mr. Darwin's work on Coral Reefs (Nature, vol. x., pp. 408-410), Prof. Dana adduces four examples of islands in which he thinks comparatively recent volcanic action has prevented the formation of extensive coral reefs. One of these is Savaii, the largest island of Samoa.

Some time ago I read Prof. Dana's "Corals and Coral Islands," while on a tour on Savaii, and on the margin of page 302 I noted this very point now brought forward by the author in his paper in Nature, intending, at some future time, to show that his view respecting this island is based upon imperfect knowledge, and is altogether incorrect.

I do not intend to enter here into all the details respecting Prof. Dana's incorrect statements, but will confine myself to the one point on which his views and those of Mr. Darwin are at variance. In his work (p. 302) Prof. Dana says: "Savaii abounds in extinct craters and lava streams, and much resembles Hawaii in character; it bears proof in every part of being the last seat of the volcanic fires of the Samoan Group. *Its reefs are consequently few and small.*" In Nature (vol. x. p. 409), he says: "Savaii has coral reefs on its *western* (eastern) and northern shores, while elsewhere without them. *I failed to find evidence in the case of either of these volcanic regions that they are situated within areas of elevation* rather than subsidence. *Only ten miles* west (this should be *east*) of Savaii lies the large island of Upolu, having very extensive reefs—on some parts of the north side three-fourths of a mile wide; and it has not seemed safe to conclude that while Upolu thus bears evidence of no movement or of but little subsidence, Savaii was one of elevation; or *that the north and west* (*east*) *sides of Savaii have differed in change of level from the rest of the island.*"

In the above passage Prof. Dana has reversed the relative positions of Savaii and Upolu. Savaii is *west* of Upolu, and its reefs are on the *eastern end next to Upolu*, and extend for some distance on its north-eastern side. Its south, west, and northwest sides are free from coral reefs *except in bays*, where they are very narrow.

Now what Prof. Dana did not consider it "safe to conclude," viz., that part of Savaii had "differed in change of level from the rest of the island," is nevertheless a *fact*. And more than that, those parts of the island which present unmistakable evidence of upheaval *are destitute of a coral reef on their shores*, except the narrow fringes above mentioned.

The elevated portions of the island commence at the south-eastern point, in a line with three small islands which stand in the straits between Upolu and Savaii, and which doubtless indicate the line of fissure. I have traced the upheaval for many miles along the southern coast. In some places there are *old water-worn cliffs* from twenty to thirty feet above the cliffs which at present form the coast line, and which are themselves from twenty to thirty feet above high-water mark. These old cliffs are usually within two or three hundred yards of the present coast line, but are sometimes more distant. I have not at present traced this upheaval around the entire western end of Savaii, but I have observed the point at which it commences on the northern side, as well as at the south-eastern extremity.

How this fact tells on the point on which Prof. Dana's view differs from Mr. Darwin's, I may leave to those who are familiar with the subject to decide. My own conviction is, that instead of furnishing proof of the correctness of Prof. Dana's view, Savaii supplies a remarkable example of the correctness of that of Mr. Darwin, that, *ceteris paribus*, the extent of coral reefs is chiefly determined by the depth of water on the coast.

I have visited and examined a good many intertropical islands of the Pacific belonging to the three orders: 1. Volcanic islands with fringing coral reefs, such as Samoa, the New Hebrides, &c. 2. Atolls, such as the Low Archipelago, Ellice, Gilbert Islands, &c. 3. Upraised coral islands, such as Niuē or Savage Island, part of the Friendly, the Loyalty Islands, &c. I have studied their structure with Mr. Darwin's "Coral Reefs" as my text-book; and the further I have gone the more firmly have I been convinced of the correctness of his theory.

Prof. Dana is, without doubt, correct in his opinion that submarine or littoral volcanic action would destroy living corals which came within its influence; and it might for a time, even after the volcano became quiescent, prevent the spread of corals within the area affected by it. But the fact that in some of the areas where extensive reefs are not found, narrow coral fringes exist in bays (as at Savaii), where the slope of the shore is less steep, is positive proof that the non-existence of extensive reefs cannot in such places be owing to any deleterious influences arising from volcanic action, but must be on account of the depth of water on the coast. S. J. WHITMEE

Upolu, Samoa

Mirage on Snowdon

ON Monday, July 12, I, with a party, ascended Snowdon. The atmosphere was clear until we had reached within half a mile of the summit, when a light cloud rising stealthily from amongst the southern peaks enveloped it. Drifting towards us, when very near, the cloud dropped over the eastern shoulder of the mountain just where it dips towards Capel Curig. As we stood watching, great was our surprise and delight as we beheld painted upon it, not the *arc-en-ciel* with which we are familiar, but a complete and brilliant prismatic circle, apparently about thirty feet in diameter, in the very centre of which we ourselves were depicted, the image being somewhat enlarged but clearly defined; as we arranged the party in groups, or bowed to each other, every form and movement was faithfully reproduced in the picture. It was now about 8 o'clock, with the sun nearly in a line with us. Our guide, who had made some hundreds of ascents, had never witnessed such a sight before. H. J. WETENHALL

Fordfield, Cambridge

OUR ASTRONOMICAL COLUMN

KEPLER'S NOVA, 1604.—We learn from Prof. Winnecke that, in consequence of the remarks upon this star which appeared in NATURE, vol. xi. p. 249, he has lately examined the neighbourhood, and, in addition to the star of 11·12th magnitude there mentioned—the position of which for 1855·0 he finds to be R.A. 17h. 22m. 4·6s., N.P.D. 111° 23·6′—he found one of 12th magnitude in R.A. 17h. 21m. 49·3s., N.P.D. 111° 19·3′. This star agrees almost precisely in place with the 10th magnitude marked upon No. 52 of Chacornac's charts, though not at present of that brightness; but we are able to state that in August 1871 and June 1872 nothing was visible in this position in a telescope which would show stars to 13·14 magnitude in Winnecke's scale. It will be desirable to watch this small star closely, as it is quite possible it might be identical with Kepler's famous star, the observed place of which is not so accurately known as in the case of the similar object observed by Tycho Brahe in 1572. Prof. Winnecke, however, suggests that, as the star marked by Chacornac is just upon the margin of his map, where some distortion exists, it might possibly be identical with No. 16,872 of Oeltzen's Argelander, a star estimated 8·9 in the Bonn Zones; still the place of the 12th magnitude agrees much more closely with that of Chacornac's 10th, read off from his chart as nearly as the circumstances permit. It may be well to compare the fainter star found by Prof. Winnecke, from time to time with the 11·12th close at hand, and easily identified if the instrument be set for Argelander's star, which may be considered a bright 9th magnitude.

THE BINARY STAR 4 AQUARII.—If good measures of this star are practicable during the present season, an idea of the form of the orbit may perhaps be obtained. Dawes's series of epochs will be of material service in this respect; without them, doubt might have been occasioned by the two discordant epochs of Mädler, which may have been owing to distorted images at low altitude. The object is certainly one of considerable difficulty, and really trustworthy measures are perhaps only to be expected from practised observers in command of instruments of excellent definition. In Barclay's second catalogue it is described as just elongated in the direction 144°, with power 450 on the 10-inch refractor at Leyton, at the epoch 1865·74; this angle shows direct progress, very much in accordance with Dawes's measures. Possibly the companion may now be found nearly due south of the primary.

THE NEBULÆ.—Prof. Schönfeld has published in Part II. of "Astronomische Beobachtungen zu Mannheim"—Carlsruhe, 1875—a continuation of the valuable series of observations commenced by him in 1860, for accurate determination of the positions of a selected list of nebulæ. In this second part we have the places of 336 of these objects, obtained by direct reference to stars, which, as in the case of those employed in fixing the positions of the nebulæ included in the first part (Mannheim, 1862), have been meridionally determined at Bonn by the late Prof. Argelander; the mean places are found in Vol. vi. of the Bonn Observations. Schönfeld's epoch is as before, 1865·0, for which year the precessions are computed with Bessel's constants, still preferred by many of the German astronomers. The differences from Schultz's Preliminary Catalogue are shown, and are generally small. As one result of more recent observations, it is remarked by Schönfeld that a sensible proper motion of the great nebula in Andromedæ, which appeared to be indicated by a comparison of Flamsteed's observations with those of D'Agelet and Lalande, is not confirmed.

Prof. Adams, in his last address as President of the Royal Astronomical Society, remarks upon the great value attaching to Schönfeld's micrometrical observations of the nebulæ, of which we have here the continuation.

ENCKE'S COMET.—Mr. J. Tebbutt of Windsor, New South Wales, reports his discovery of a comet, which he supposed to be Encke's, on the morning of May 7th, in the constellation Cetus. It is, we believe, the second occasion upon which this able amateur astronomer has detected this comet, before the arrival of an ephemeris from Europe, and no doubt in the present case his independent discovery, which he communicated telegraphically to the Government astronomers at Sydney and Melbourne, will lead to a number of observations for position at the Australian observatories, which might have been otherwise lost. The search for comets without the aid of an ephemeris is hardly an occupation which can be expected in a public observatory, where time is valuable for routine work—hence an argument for the early and general publication of ephemerides—and an inducement for some amateurs, especially in southern latitudes where a great necessity for systematic sweeping of the sky in search of comets appears still to exist, to so employ their leisure time. One at least of the lost comets of short period, is far more likely to be recovered in the southern hemisphere, than in these latitudes.

THE ARGENTINE OBSERVATORY.—Dr. Gould has just circulated in two small pamphlets, in English, the annual Report for 1874 of proceedings at the Observatory of Cordoba, and at the Meteorological Office, which has also been organised by this distinguished astronomer. With regard to astronomical work, the observations for the "Uranometry" are completed, as already mentioned in this column. The charts will be thirteen in number, including the whole of the southern heavens as well as the first ten degrees north of the equator, and about 8,500 stars will be represented upon them, of which about nine-tenths have southern declination. A catalogue will accompany the Atlas, as with the works of Argelander, Heis, and Behrmann. The zone-work was in a very forward state, 82,537 stars having been observed, and with the exception of an insignificant number of zones for which it might be necessary to wait till a later period of the year, Dr. Gould expected to complete this laborious undertaking by the end of last month. The third of the principal sub-divisions of work at Cordoba, the formation of what is called "the smaller Catalogue" is also well advanced: the catalogue is intended to consist of nearly 5,000 of the brighter stars of the southern heavens, each one observed not less than four times; in the year 1874, 12,500 observations of 3,600 different stars were made, the greater number during Dr. Gould's visit to his native city, a sufficient proof that he has been zealously supported in the extensive plans of observation arranged by him, by the other officers of the establishment. The great comet of 1874 was followed with the large refractor of the Argentine Observatory (which, Dr. Gould informs us, is an 11-inch by Fitz, of New York) until the 18th of October, the comet having been first seen there, in the morning twilight on July 27; at the last observation it was within about 12° of the South Pole. [Our last remarks on this comet should have been headed Comet, 1874 (III.)].

THE LATE W. J. HENWOOD, F.R.S.

THIS distinguished mining geologist, who died at Penzance last week, in his seventy-first year, was originally a clerk in the employment of Messrs. Fox, of Falmouth, to whose counsel he was considerably indebted in his early scientific work. By very great industry and careful observation he acquired an unsurpassed knowledge of the mineral deposits of Cornwall and Devon, and after fulfilling a succession of important mining appointments, he became Assay Master of tin to the Duchy of Cornwall. This post being abolished, Mr. Henwood's great experience was utilised in reporting upon and developing a number of mining districts in South America, Canada, &c.; and after the cessation of his travels, he lived at Penzance in comparative retirement. His great works are the fifth and eighth volumes of the "Transactions of the Royal Geological Society of Cornwall," devoted respectively to the metalliferous deposits of Cornwall and Devon, and to those of the foreign countries he had visited. But his scientific writings, besides these, were very numerous; a list of them occupies seven columns in the "Bibliotheca Cornubiensis."

As a scientific man Mr. Henwood was characterised by indefatigable labour, great caution, love of accuracy, and moderation of expression. In his publications he scarcely ever mentions a fact of any kind which had not come under his own experience, without giving the authority for it. Thus many of his writings are marvels of copious reference. He persisted in doing everything with this extraordinary amount of labour and care up to the last, notwithstanding that he suffered for many years from a very painful heart-disease. His scientific work ceased only with his death. So long as he could sustain even an hour's intellectual effort during the day, that was devoted to the arrangement of his stores of facts and observations. I believe that scarcely one of his cherished objects in this respect remains unfulfilled.

Mr. Henwood's address to the Royal Institution of Cornwall in 1871, extending, with references, to sixty-five pages, affords ample evidence of the value of his observations and of his scientific ability. It includes the most admirable and complete compendious account of the mode of occurrence of metalliferous deposits in Cornwall which has yet appeared, and is characterised by that absence of theoretical assumption which specially marked him as an observer. The orderly arrangement of accurately-observed facts was his object; theorising he had little affection for; suspended judgment on unproved theories was his consistent attitude.

In personal character Mr. Henwood won the high regard of all who knew him intimately. His acquaintance with men and manners was so great and varied, his memory so retentive, and his conversational style so simple and lucid, that to talk with him was one of the most delightful and instructive of intellectual recreations. His estimate of his own labours and merits was unaffectedly modest, although he would resist, if possible, any unfair representation of his work.

In the spring of the present year the Murchison Medal of the Geological Society was awarded to Mr. Henwood. An extract from a letter written by him to a friend on this subject may fitly close this notice: "Mr. Evans's far too flattering estimate of my poor labours was most kindly intended. Although the distinction cannot but afford me pleasure, this is as nothing compared with the kind, and even affectionate, congratulations of yourself and my other friends. All these I carefully preserve, as they will show what I have done far better (though in an undeservedly favourable light) than the mere official record."

G. T. BETTANY

THE INTERNATIONAL CONGRESS AND EXHIBITION OF GEOGRAPHY

THE Geographical Exhibition continues to have increasing success, although the price of admission has been raised, except for schools, for which the original price, a penny a head, has been kept, and the galleries are crowded with children under the guidance of their teachers. It is said that all the soldiers of the garrison of Paris will be marched through the galleries under the guidance of their officers, when the Congress is over. The Exhibition will be prolonged to the end of the month.

Several improvements have been made in the English section since our last notice. Examples of the several maps published by the Ordnance Survey have been exhibited from an inch to ten feet per mile. Although completed only at a late period, the exhibition of the Geological Survey of Great Britain has been very successful; an immense number of maps have been exhibited, and are said to be the finest in the whole exhibition building. We might refer to a number of other exhibits honourable to English enterprise, but we must confess that Russia has carried the day, not on account of her private enterprise, but in consequence of the strenuous action of the Government. It is very likely that St. Petersburg will be chosen by common consent for the seat of the next geographical exhibition.

M. Glœsener, member of the Royal Academy of Sciences of Belgium, exhibits a chronograph available for registering the flight of projectiles as well as for recording astronomical observations for the determination of longitude. The cylinder can be put into rotation at the rate of four turns in a second or one turn in thirty seconds, according to the order of phenomena. It requires only the power of Daniell cells and ordinary magnet needles, without any electrical spark. It is very cheap, compact, and easy to set in operation.

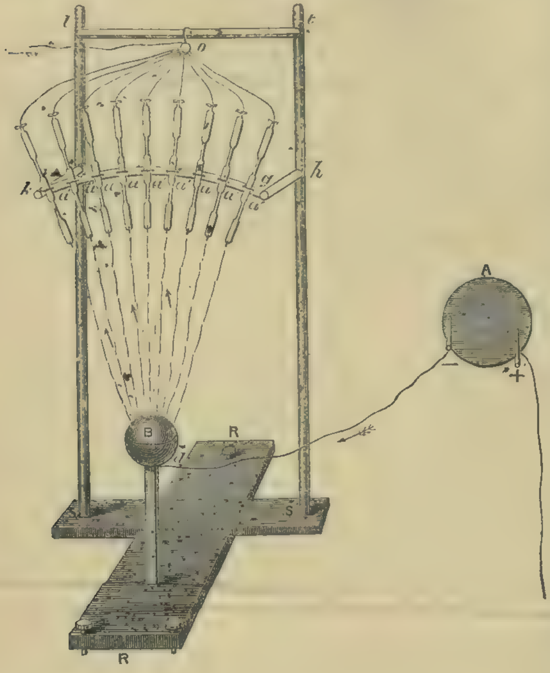
The Rysselberghe self-registering meteorograph has been admitted, as we have already noticed, to supersede any similar instrument in existence. Copper plates engraved automatically can be used in printing, having turned into relief by the processes already described.

M. Lynström, of the University of Helsingfors, has sent to the Geographical Exhibition an interesting instrument invented by him to demonstrate that auroræ are produced by electrical currents passing through the atmosphere in the polar regions. The apparatus is put daily into operation by M. Mohn, the director of the Meteorological service of Sweden, and it was constructed at the expense of Mr. Oscar Dickson, the Gottenburg merchant, who has fitted out the Swedish Polar Expedition under Prof. Nordenskiöld. Our illustration will give an idea of the apparatus.

A is an electrical machine, the negative pole being connected wtih a copper sphere and the positive with the earth.

S S′ are of ebonite as well as R R *d d*, so that B is quite isolated as the earth in the space. B is surrounded by the atmosphere. *a′ a′ a′ a′ a′ a′* are a series of Geissler tubes with copper ends above and below. All the upper ends are connected with a wire which goes to the earth, consequently a current runs in the direction of the arrows through the air, and the Geissler tubes become luminous when the electrical machine is set into operation.

These Geissler tubes represent the upper part of the atmosphere which becomes luminous when the aurora borealis is observed in the northern hemisphere. The phenomena produced by the Lynström apparatus are quite consistent with the theory advocated by Swedish observers that electrical currents emanating from the earth and penetrating into the upper regions produce auroræ in both hemispheres. The experiment differs from the apparatus of M. De la Rive, who placed his current *in vacuo*, and did not show the property of ordinary atmospheric air of allowing to pass unobserved at the pressure of 760 mm. a stream of electricity which illuminates a rarified atmosphere. The experiment is most attractive, and hundreds of persons witness it every day.



The arrangements for the general daily meetings of the Congress are very good. Every morning the seven sections meet at nine o'clock and discuss the subjects placed on the *ordre du jour*. At three o'clock all the members meet in the Salle des Etats, under the presidency of one or other of the presidents of the various geographical societies of Europe. No discussion takes place at these general meetings, but the presidents of sections report on the discussions which have taken place at the morning sitting. Consequently, all who attend the evening meeting obtain a summary of the transactions of the day. Visitors are admitted to the general meetings only. Sometimes several sections meet together in the morning to deliberate on subjects of common interest, and general deliberations will be proposed at the end of the session.

A subject very much discussed has been the adoption of a first meridian. Struve proposed Greenwich. One of the most interesting questions has been on the substitution of the centesimal for the sexagesimal division of the quadrant, or of the entire sphere. It was decided by twenty-three to seven in favour of the centesimal division of the quadrant, reserving the larger question of its extension to the entire sphere till the matter is brought before the general meeting. The present system found no advocate. M. Bousquet de la Grie's proposal for dividing the compass into 360 points, to be reckoned from left to right, has also been approved.

The question of ascending currents in the atmosphere has been seriously discussed, M. Faye maintaining that only descending waterspouts have been observed. M. Faye's theories, however, have found very little support. The general opinion, as supported by Mohn and others, being that no descending current can be observed without an ascending one, so that there is a circular rotation of the atmosphere in altitude, and the upper strata are in constant communication with inferior strata of the atmosphere.

A commission has been appointed on the question of a great Transiberian railway. The Russian colonel Bogdanovitch spoke in favour of a line by Ekaterineburg and Tiumen, which has the advantage of putting Europe into communication with the large rivers of Southern Siberia. He said that the Russian government had decided upon the construction of a section 1,000 miles long.

Lectures were delivered by MM. Gerard Rohlfs, Nachtigall, and Schweinfurth, on the exploration of Central Africa, and these intrepid explorers answered a number of questions in reference to their travels.

On Sunday about 300 members, amongst them a number of ladies, visited Compiègne to see the museum of Cambodian antiquities, collected by M. Delaporte, a lieutenant in the French national service, and exhibited in the ex-imperial palace inhabited by Napoleon III. M. Delaporte published in 1873, at Hachette's, a large work in two folio volumes, with an immense number of illustrations, and a graphic atlas in chromolithography. The King of Cambodia, having been admitted to a French protectorate, sent a number of antiquities to Compiègne, where M. Delaporte has organised the museum which was visited on Sunday. M. Delaporte himself was in attendance to explain the manner in which all those astonishing relics of an unknown part had been brought to light. These monuments have undergone a systematic destruction, it is supposed, in the fifth century B.C., and are mostly concealed in the centre of immense forests which have grown since that time, and situated in infested districts which are mostly inhabited by tigers and poisonous snakes. It was M. Jules Simon who had the honour to grant the mission whose results have been so fruitful, and the zeal elicited by explorers was so great that the credit of 10,000 francs granted was almost sufficient to collect a quantity of stones which fill the basement of the Palace.

Of the juries appointed by the Geographical Congress five have given their awards, while the remaining two have not yet come to any decision. Letters of distinction, the highest reward the Congress can bestow, have been conferred upon England—namely, in Group 1 upon the Topographical and Trigonometrical Office of India and the Ordnance Survey Office of Southampton; in Group 2 upon the Hydrographic Office; in Group 3 upon the Meteorological Office, the office of Geological Survey of Great Britain, and the Royal Geographical Society of London; in Group 4 upon the Palestine Exploration Fund for maps and plans and photographic reliefs. Letters of distinction have also been conferred in the United States upon: Group 2 the Navy Department; Group 3 the United States Signal Service, and upon Mr. William Martin for a description of the island of Hawai. Numerous first-class medals have, moreover, been conferred upon Englishmen and Americans.

THE MANATEE AT THE ZOOLOGICAL GARDENS

Of those mammalian animals which, instead of making their customary abode the land, reside in water either fresh or salt, the Seals and Porpoises are best known by sight to the public at large. These two just named animals are representatives of two great zoological groups, the Pinnipedia and the Cetacea, the relationships between which are not at all intimate; in other words, notwithstanding the similarity in their habits, they must have been derived independently from different, probably terrestrial, mammalian ancestors, which themselves were not intimately related. The Pinnipedia include the Seals, Sea-Lions, and Walruses, animals closely allied to the Bears, Dogs, and Cats. The Cetacea include the Whales, Dolphins, and Porpoises, which are so much modified that their correct affinities are still matters of doubt.

There is, however, still another aquatic mammalian group or order which at the present time includes among its members only two well-marked forms or genera; these being the Dugong and the Manatee. The order is that of the Sirenia, and its members differ in their organisation considerably from both the Seals and the Whales, more nearly approaching the latter, and appearing to be most nearly allied to the Ungulate Herbivora.

The Manatees—of which there are two well-defined species, one found in and at the mouths of the rivers discharging themselves on the eastern coast of intertropical America, and the other on the opposite side of the Atlantic Ocean, on the shores of Western and Southern Africa—are large-sized somewhat seal-like herbivorous animals, sometimes reaching 17 feet in length, differing from the Seals and resembling the Whales in not having any indications of hinder extremities, at the same time that the caudal portion of the body is expanded into a horizontally-flattened tail. In them the contour of the face is peculiar, the whiskered snout being much flattened, like a pointed cone with a considerable portion of the end cut off transversely. The large nostrils are situated within a short distance of one another, at the upper portion of the truncate edge; they are closed by valves during the time that the animal is submerged. The eyes are peculiarly small and inconspicuous. The external ears are wanting. The mouth is small, without front teeth, and is placed low down, the gape being close to the anterior end of the animal. The neck, from its extreme shortness, can scarcely be said to exist as such.

Neglecting the tail, the body, which is very sparsely covered with hair, has the shape of a much elongate barrel, slightly flattened above and below. The skin is very like that of the Hippopotamus. Far forward, just behind the head, the two fore-limbs project laterally from below. The elbow is conspicuous, though placed not far from the side, and the fore-arm together with the hand, form a flat oval flapper devoid of any indications of fingers, except that at the extreme edge rudimentary nails are developed. These arms are used by the animal as claspers, which can be flexed over the chest; employed as locomotor organs at the bottom of the water, or made to assist in the prehension of food. In the female the mammæ are pectoral, and the consequent general configuration has probably led to the fabulous descriptions of the existence of "mermaids."

In shape the tail is unlike that of any other animal, being spatulate. It most resembles that of the Beaver, but is a direct continuation backwards of the body, and is covered with an unmodified skin. As in the Whales and Beavers, the vertebral column forms a bony axis of support for the flattened muscular and fibrous expansion covered with thick cuticle, which forms the propelling mechanism.

The skeleton is of an extremely dense texture and very massive; the skull and ribs more resembling ivory than bone. In the number of the vertebrae which form the neck there is also a peculiarity, not shared even by its ally, the Dugong. In all mammalia there are seven cervical vertebrae, the same in the Giraffe as in the Elephant, in the Kangaroo as in Man. In the Manatee there are, however, only six, as in one other mammal only, namely, Hoffmann's Sloth. The ribs, as well as being very dense, are broader than is usually the case. As in the Whales there are no bony traces of hind limbs, a rudimentary pelvis being alone found.

As far as the soft parts are concerned, it may be mentioned that the apex of the heart is deeply cleft, more so than in the Elephant and the Seals. This is the case also in the Dugong. The arteries in many parts break up into innumerable minute branches before they become distributed, to form the so-called *retia mirabilia*. The lungs run a considerable distance along the back of the animal, nearly reaching the root of the tail, instead of being entirely included in the thoracic region.

The half-grown female Manatee which has just reached the Zoological Society's Gardens, is the first living specimen which has been seen in this country. It came from the coast of Demerara, and was three weeks on the journey, during which time it was in a big swinging tank constructed to hold it. Two previous unsuccessful attempts were made in 1866 to forward living specimens to Regent's Park; in one case the animal did not die till within two days of its reaching Southampton. The valuable memoir by Dr. Murie in the eighth volume of the Society's *Transactions* was based on the dissection of these two specimens, which were preserved immediately they died in a condition fit for minute investigation.

The living animal appears to be in a good state of health, its movements are much less active than those of the Seals, and as food it takes vegetable marrow and lettuce in preference to anything else.

A third member of the order Sirenia was the *Rhytina*, a toothless animal, sometimes reaching 24 feet in length, discovered by Steller during Behring's expedition in 1741 on the shores of the island which bears his name. The slaughter of these creatures for their flesh was so recklessly conducted that they had all disappeared in 1789, and have never been seen since. There are three skeletons of this extinct species (*Rhytina stelleri*) in existence, all in Russia.

THE WÖHLER FESTIVAL

THE 31st of July was a festive day for Chemical Germany, and for the numerous admirers of the celebrated senior of German chemistry, Prof. Wöhler of Göttingen; not only as the seventy-fifth anniversary of his birth, but also as the supposed fiftieth anniversary of his entering upon his professional duties. In 1825 Dr. Wöhler became teacher of chemistry to the Berlin "Gewerbeschule;" in 1831 he exchanged this position for a similar one in Cassel, and from 1836 up to the present day he has been forming generations of chemists who flocked to Göttingen attracted by his fame. We need not remind our readers of the numerous discoveries of this great and genial man, of which the artificial formation of urea, the production of aluminium, his researches on cyanic and cyanuric acids, on boron and silicon, his joint researches with Liebig on uric acid and benzoyl-compounds, and many others, are known to all chemists, and have opened new roads to science.

From eight o'clock in the morning until noon of the above-mentioned day, one deputation relieved another to express their thanks and congratulations. The Faculty of Science of Tubingen sent a diploma of Doctor of Science, so that similar to the triple crown of the Head of the Roman Church, three doctor's degrees, that of Medicine, of Philosophy, and of Science are now worn by the Head of German Chemistry. The German Chemical Society at Berlin was represented by three members of iits council, two of this deputation being pupils of Dr. Wöhler. They presented an appropriate address in a handsome cover of malachite, an allusion to the services rendered by the great chemist to the allied science of mineralogy. In the evening many of the undergraduates of the University (now eleven hundred in number) expressed their admiration in the time-honoured shape of a torch procession.

The following day found Prof. Wöhler unbent by the honorary burden of the 31st of July, and some privileged friends and pupils had the pleasure of seeing him working at the analysis of a new mineral with the same zeal he would have shown fifty years ago. This formed the most pleasant part of the Wöhler Festival, being a hopeful sign of the vigour and power left to this great man. The readers of NATURE (vol. xii. p. 179) were able, only a few weeks ago, by the perusal of extracts from charming recollections of Prof. Wöhler's youth, to witness a similar proof. In fact, his youth has accompanied him into his old age. A. OPPENHEIM

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*THE GIGANTIC LAND TORTOISES OF THE MASCARENE AND GALAPAGOS ISLANDS**

III.

I WILL now indicate the characteristics of the different races which I have been able to recognise in the materials to which I have had access.

It has been mentioned above that the principal mark of distinction is in the form of the skull: some species having a depressed skull with the surface flat above, whilst in others it is much higher and convex above. Hand-in-hand with this difference in the skull goes another in the pelvis; the flat-headed Tortoises having a broad, horizontally dilated bridge between the obturator foramina, whilst in the round-headed form the bridge is vertically compressed. Such a distinction might have been expected between the Galapagos Tortoises on the one hand, and the Mascarene races on the other; but what justly excites our surprise is that the Galapagos Tortoises and the extinct forms of the Mascarenes belong to the same (the flat-headed) type and that, therefore, a much greater affinity exists between them, than between the extinct and living races of the Mascarenes.

I.—FLAT-HEADED TYPE

A. The *Galapagos Tortoises* may be recognised by the invariable absence of a nuchal plate, by the convergence of the posterior margins of the two gular plates which never form a straight line, by the black colour of the shell, by a large scute of the inner side of the elbow, by the double alveolar ridge of their jaws. Among the carapaces which I have examined I can distinguish five forms; of the first four severally two are more nearly related to each other than to the other pair, the fifth being intermediate between these two pairs. The degree of distinctness and affinity which obtains in the carapaces is expressed clearly and in exactly the same manner in the skulls, as will be seen from the following characteristics:—

1. In the first species (*Testudo elephantopus* of Harlan) the shell is broad and depressed, with the upper anterior profile sub-horizontal in the male, and with corrugated but not deeply sculptured plates. Sternum truncated behind. The snout is very short. Skull with an immensely developed and raised occipital crest, with a sharp outer pterygoid edge, and a deep recess in front of the occipital condyle. The skeleton of a fully adult male example and one of an immature female are in the Oxford Museum and the collection of the Royal College of Surgeons. Young individuals are by no means scarce in collections. Either this species or the next appears to have inhabited James' Island.

2. *Testudo nigrita* has likewise a broad shell which, however, is considerably higher than in the former species; the anterior profile in the male is declivous, and the plates are deeply sculptured. Sternum with a triangular excision behind. The snout is longer and the occipital crest low; but the outer pterygoid edge is equally sharp, and the recess in front of the occipital condyle equally deep as in *T. elephantopus.* The principal specimens examined by myself of this species, are one 41 inches long, in the British Museum; the type of the species (described and named by Dumeril and Borbron) in the collection of the Royal College of Surgeons; and the large skull in the British Museum, figured by Dr. Gray under the name of *Testudo planiceps.*

3. Porter's account of the race inhabiting Charles Island is sufficiently characteristic to enable us to recognise it in an adult specimen, the shell of which is elongate, compressed into the form of a Spanish saddle, and of a dull colour without any polish. The sterum is truncated behind. Skull with the outer pterygoid edge flattened, with the tympanic cavity much produced backwards, and without recess in front of the occipital condyle. The only adult example wdich I have examined is 33 inches long, and belongs to the Museum of Science and Arts, Edinburgh. It was lent to me by the Director, Mr. T. C. Archer, who most kindly allowed the skull and limb-bones to be extracted, which could be effected without the least injury to the outward appearance of the specimen. This species I have named *Testudo ephippium.*

4. The smallest of the Galapagos Tortoises is one for which I have proposed the name *Testudo microphyes*, the carapace of a fully adult male being only 22½ inches long. We may presume that this specimen, for an examination of which I am indebted to the Museum Committee of the Royal Institution of Liverpool, is a representative of the race from Hood's Island, Porter having expressly stated that the tortoises of that island are small, and similar to those of Charles Island. Indeed, the shell is elongate as in *T. ephippium*, but the anterior profile is declivous. The skull has the characteristics of a young skull of one of its more gigantic congeners; the outer pterygoid edge is flat, and there is no recess in front of the occipital condyle, as in the species from Charles Island.

5. In the last species (*Testudo vicina*) the skull is depressed as in the first, with the upper exterior profile sub-horizontal in the male, and with the lateral anterior margins reverted so as to approach the peculiar shape of *T. ephippium.* The concentric sculpture of the plates is distinct. Sternum of quite a peculiar shape, much constricted and produced in front, and expanded and excised behind. The skull is extremely similar to that of *T. ephippium.* Unfortunately nothing is known of the history of the adult male example which formerly was in the possession of Prof. Huxley and ceded by him to the collection of the British Museum.

B. The *Mauritian Tortoises.*—It would be a matter of considerable interest to ascertain whether the tortoises of Mauritius lacked the nuchal plate, like the Galapagos races to which in other respects they are so closely related. The only carapace which I have seen is deprived of the epidermoid scutes, and, besides, so much injured in the nuchal region that it is impossible to determine the absence or presence of a nuchal plate. But the Mauritian tortoises were characterised by a peculiarity hitherto unknown among recent land tortoises, viz., by a treble serrated dental ridge along the lower jaw.

The examination of a considerable number of bones, part of which were obtained during the search for Dodo-bones, and are now in the British Museum, whilst for others from the district of Flacq I am indebted to M. Bouton, has convinced me of a multiplicity of species in this island. The majority of the bones were found near Mahe'bourg, in a ravine of no great depth or steepness, which apparently once conveyed to the sea the drainings of a considerable extent of circumjacent land, but which has been stopped to seaward most likely for ages by an accumulation of land. The outlet from this ravine having been thus stopped, a bog was formed called "La Mare aux Songes," with an alluvial deposit varying in depth from three to twelve feet. The tortoise bones occur at a depth of three or four feet, imbedded in a black vegetable mould; lighter coloured specimens are from the vicinity of the springs. (Zool. Trans., vi. p. 51). Among these bones I have distinguished four species, the more important characteristics of which may be particularised as follows:—

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* The substance of this article is contained in a paper read by the author before the Royal Society in June, 1847, and will appear in the forthcoming volume of the "Philosophical Transactions," and to which I must refer for the scientific portion and other details. Some facts which have come to my knowledge subsequently to the reading of this paper, are added. Continued from p. 261.

1. *Testudo triserrata.*—Proximal half of the scapula trihedral, with the anterior side convex; acromium trihedral, straight. Coracoid anchylosed to scapula at an early stage of growth. Humerus moderately slender, with the shaft flattened, and a deep hollow between the head and tuberosities. Shaft of the ulna narrow, much twisted. Ossa ilei short and broad; transverse and vertical diameters of pelvis subequal; front part of pubic bones abruptly bent downwards. Femur stout, with much dilated condyles; a deep and broad cavity between the head and trochanters.

2. *Testudo inepta.*—Proximal half of the scapula trihedral, with the anterior side concave; acromium compressed, with the end curved. Coracoid never anchylosed to the scapula. Humerus moderately slender, with the upper half of the shaft trihedral, and without hollow behind the head. Shaft of the ulna broad, not much twisted. Ossa ilei narrow and long; vertical diameter of pelvis much exceeding in length the horizontal; front part of pubic bones gently declivous. Femur stout, with much dilated condyles, and with a deep and narrow cavity between the head and trochanters.

3. *Testudo leptocnemis*, sparsely represented, with a scapulary similar to that of *T. triserrata;* ossa ilei of moderate length and width, femur slender, with moderately dilated condyles, and with a deep and broad cavity between the head and trochanters.

4. *Testudo boutonii*, known from scapulary and humerus only. The former bone is strongly compressed; acromium with the end curved. Coracoid not anchylosed to scapula. Humerus very stout, with the shaft trihedral in its whole length, and without hollow behind the head.

C. The *Rodriguez Tortoise.*—The remains from Rodriguez which I have hitherto examined, and for which I am indebted to M. Bouton and to the trustees of the Glasgow Museum, consist of fragments of the cranium, perfect cervical vertebræ, pelvis, and the larger leg-bones. They indicate one of the best marked species of the entire group, with a double alveolar ridge, and with the neck and limbs of greater length and slenderness than in any other species. The neural arch of the sixth nuchal vertebra is perforated by a large ovate foramen on each side close to the anterior apophyses. These perforations were closed by membrane in the living animal, and evidently caused by the pressure of the apophyses of the preceding vertebra, the animals having had the habit of bringing the neck in a vertical position, so that these two vertebræ were standing nearly at a right angle. Some of the bones are exceedingly large, larger than any of those from the Mauritius, and must have belonged to individuals of the size of our large living male from Aldabra.

II.—ROUND-HEADED TYPE: *T. indica.*

To this type belong all the specimens with a nuchal plate which have been deposited in British collections within the last forty years, or which elsewhere have been described or figured; and more especially the Tortoises from Aldabra. Whether all these specimens have come from this small group is impossible to say, as we know very little or nothing of their history. Although I have succeeded in bringing together a considerable number of specimens, from which it would appear that also in this much smaller division several races could be distinguished, I think it best to defer, for the present, the detailed publication of the results of my examination which ere long may be supplemented or modified by important accessions.

In conclusion we may ask whether the facts which I have endeavoured to place before the readers of NATURE are more readily explained with the aid of the doctrine of a common or manifold origin of animal forms.

The naturalists who, with Darwin, maintain a common origin for allied species, however distant in their habitats, will account for the occurrence of the tortoises in the Galapagos and Mascarenes in the same way as, for instance, for the distribution of the Tapirs, viz., by the hypothesis of changes of the surface of the globe. Taking into consideration other parts of the Faunæ, they would have to assume, in this case, a former continuity of land (probably varying in extent and interrupted at various periods) between the Mascarenes and Africa, between Africa and South America, and finally between South America and the Galapagos. Indeed, the terrestrial and freshwater faunæ of Tropical America and Africa offer so many points of intimate relationship, as to support very strongly such a theory. The Tortoises, then, would be assumed to have been spread over the whole of this large area, without being able to survive long the arrival of man or large carnivorous mammals. The former, especially before he had provided himself with missile weapons, would have eagerly sought for them, as they were the easiest of his captures yielding a most plentiful supply of food; consequently they were exterminated on the continents, only some remnants being saved by having retired into places which by submergence became separated from the mainland before their enemies followed them. With this hypothesis we would be obliged to contend for this animal type an age extending over enormous periods of time, of which the period required for the loss of power of flight in the Dodo or Solitaire is but a fraction.

To my mind the advocacy of an independent origin of the same animal type, however highly organised, in different localities, seems equally justified. It has been urged that closely similar structures of the animal organism have been developed without genetic relationship; so, also, the same complex organic compound, as sugar, is produced normally by the plant and abnormally by the human organism. Without overstepping too far the limits of probability, we may assume that some Land-Tortoises were carried by stream and current from the American Continent to the Galapagos, and that others from Madagascar or Africa, found in a similar manner a new home in the Mascarene Islands. These tortoises may originally have differed from each other, like the *Testudo tabulata, radiata, sulcata* of our days, possibly not exceeding these species in size, but being placed under the same external physical conditions evidently most favourable for their further development, they assumed in course of time the same gigantic proportions and other peculiarities, the modifications in their structure which we observe now being partly genetic, partly adaptive.

Thus this curious phenomenon in the geographical distribution of animals can be explained by either of those two theories, and does not appear to me to strengthen the position of one more than that of the other. The multiplicity of the races which I have pointed out above I need not further discuss. As regards the Galapagos, this fact is quite in accordance with what has been long recognised in the distribution of the birds of the same archipelago, and the co-existence of several races in Mauritius is perfectly analogous to the variety of species of Dinornis in New Zealand.

ALBERT GÜNTHER

NOTES

PROF. SCHÖNFELD, of Mannheim, has been appointed successor to the late Prof. Argelander as Director of the Observatory at Bonn, and will enter upon his duties on Sept. 1. Dr.

Valentiner, chief of the German Astronomical Expedition to Cheefoo, and first assistant at the Leiden Observatory, will succeed Schönfeld at Mannheim.

THE biennial general meeting of the essentially International Astronomical Society will be held at Leiden from the 13th to the 16th inst.

THE Professorship of Natural History at the Newcastle College of Physical Science, vacated by the removal of Dr. Alleyne Nicholson to St. Andrews, has been filled by the appointment of Mr. George S. Brady, of Sunderland. The chair has hitherto been held in conjunction with the Lectureship on Physiology in the Durham University College of Medicine, in Newcastle, a union which it has been found expedient to abolish. The appointment we now record will be regarded with satisfaction by every one who is desirous of seeing the value of the labours of our working naturalists duly recognised in the localities where they have carried on their work.

THE Natural History Society of Newcastle, one of the best in the kingdom, appears to be going through a crisis. At a recent meeting, several of the honorary curators sent in their resignations, including names so well known as H. B. Brady, G. S. Brady, H. B. Bowman, Lebour, and Freire-Marreco, together with both the secretaries. We understand that an informal meeting has been held by a number of those interested in the systematic teaching of natural history, to take steps for obtaining specimens to form an independent typical collection for the use of the professors of the College in their lectures. This is as it should be. Collecting for mere collecting's sake is no part of science; as an adjunct to systematic teaching it is invaluable. A great centre like Newcastle should possess such a collection formed for such a purpose; and the effort is worthy of support and assistance from all friends of science teaching.

AT the distribution of prizes to the Taunton College School by the High Sheriff of Somerset on July 29th, the headmaster, Mr. Tuckwell, commented severely on the exclusion of science from the competition of the Huish Scholarship, to which we drew attention in these columns some weeks ago. The High Sheriff said that he was one of the Trustees who had prepared the scheme; that, looking to the Founder's expressed desire to forward the study of theology, they had wished so to shape the examination as to carry out his views; but that the Trustees were not a bigoted body, nor unduly wedded to their first opinion; that Mr. Tuckwell's criticisms deserved attention; and that he promised on behalf of the Trustees to reconsider the arrangements before another year. In thanking the High Sheriff for the liberal tone in which he had met the questions raised, Mr. Tuckwell protested against the belief that a divine worthy of the name could be trained in the present day by any system of education which should exclude a deep knowledge of science.

M. MOUCHEZ, the new member of the Academy of Sciences, has just organised a Practical School of Astronomy at Montsouris. Refractors, equatorial as well as meridian, and horizontal telescopes will be placed at the disposition of any competent person wishing to be instructed in astronomy. An astronomer from the National Observatory will instruct the pupils without fee; the Minister of Marine has ordered that two marine officers should always be in attendance for this purpose. The course of instruction will embrace celestial photography and spectrum analysis. No qualification of nationality will be required for admittance, only general competency.

M. WURTZ, Professor in the Faculty of Medicine of Paris, has been appointed Professor in the Faculty of Sciences.

THE French Association for the Advancement of Science commences its sittings at Nantes this day week.

M. LE VERRIER has presented to the Prefect of the Seine a plan for connecting, by means of a telegraphic network, all the public clocks of Paris with the principal clock of the Observatory.

THE British Medical Association brought its Edinburgh meeting, which has been a very successful one, to a close last Friday. Brighton has been selected as the place of meeting for next year, with Sir J. Cordy Burrows as President-elect.

IT turns out that in the recent attack on the Palestine Exploring party, there were nine wounded, including Lieutenants Conder and Kitchener. Measures have been taken to secure the arrest and punishment of the assailants.

IT appears from a letter in Friday's *Times* that that most interesting relic of antiquity, "Cæsar's Camp" at Wimbledon "is being deliberately levelled to the ground, effaced and destroyed by its owner, Mr. Drax, the member for Wareham." It is difficult to believe in an act of such deliberate vandalism. Mr. Drax is stated to have asked such an exorbitant price for the land that negotiations were rendered impossible; had Sir John Lubbock's "Ancient Monuments Bill" been passed this session, this evidently doomed and unreplaceable monument of antiquity could easily have been saved, and the owner would have received a fair price for his land.

M. WILFRID DE FONVIELLE made a successful night ascent on August 1, for the purpose of observing meteorites. From 10 P.M. to 4 A.M., forty-two meteorites were observed between Rheims and Fontainebleau. Some of these emanated from Cassiopeia, others from Perseus, and as many as nine took a vertical direction, descending from the part of the heavens which was concealed by the balloon. None of these were very noteworthy, and it is probable that none would have been observed at the surface of the earth. Eight persons were in the car, and another trip was to be made last Sunday from Paris.

THE International Geographical Exhibition is not the only one of the kind now open in Paris; as our readers no doubt know another has been established by M. Nicolle at the Palais des Champs Elysées for Fluviatile and Maritime Industries, and is attracting an immense number of visitors. It will continue up to the month of November, when another will be opened for Electrical Industries. The English Section in the Fluviatile and Maritime Exhibition is very successful. The Board of Trade has sent specimens of the apparatus in use for salvage and for warnings at British seaports; the contributions by private individuals also give a fair idea of British Maritime Industries.

ON Saturday last a deputation from the Royal Colonial Institute waited upon Lord Carnarvon to urge upon Government the propriety of establishing a Colonial Museum in London. The Government, it seems, have been entertaining the idea of establishing such an institution, and Lord Carnarvon spoke hopefully of the possibility of accomplishing the praiseworthy object; he thinks it would be well to place it contiguous to the India Museum.

A CORRESPONDENT of the *Illustrated London News* of Aug. 1, writes, July 25, from Pen-y-Gardden, Denbighshire, describing a shower of hay similar to that referred to in last week's NATURE, p. 279, as having occurred at Monkstown. It passed over the town of Wrexham, five miles distant from Pen-y-Gardden, and in a direction contrary to that of the wind in the lower atmosphere.

MR. MAGNÚSSON, writing to yesterday's *Times*, reports the continued outbreak of volcanic eruptions in various parts of Iceland, and makes an earnest appeal to the British public for help to those, and they are many, who have been rendered quite destitute—landless and homeless—by the calamity. No people are more deserving of help than the Icelanders, and moreover, they have the claim upon us of close kindred.

We have received the "Fourth Report of the Meteorological, Magnetic, and other Observatories of the Dominion of Canada for 1874," pp. 316. The Report gives full details of the tri-daily observations made at the various meteorological stations, the monthly means and extremes, and, as regards temperature and rainfall, a comparison of the results of 1874 with the averages of previous years. The most important fact perhaps noted in the Report is the gradual extension of the system over British North America.

From a letter from the Canada correspondent of *The Scotsman*, dated 23rd July, 1875, we learn that the summer in Canada has been unusually cold. The nights have been quite chilly so as to necessitate extra covering; and during the whole summer the temperature has only once reached 90°; on the evening of the 18th July it fell to 43°. Capt. Richardson, of the *Nova Scotian*, which had just arrived, reports having passed a large number of icebergs on the coast, and having sailed through floating ice for twenty-four hours. Reports from the extreme north state that the ice had given way to a greater extent than for many years, in which case the Arctic Expedition will probably reach a higher latitude before the summer closes than was expected.

In the *Bulletin Hebdomadaire* of the Scientific Association of France it is stated, after a careful review of the loss sustained by the different districts, that the total loss caused by the late inundations in the South of France exceeds the enormous sum of eighty millions of francs, and that 550 persons perished.

The June number (just issued) of the *Bulletin* of the French Geographical Society contains an interesting chart of the world, by M. Malte-Brun, intended to exhibit at a glance the proportion of the known and unknown regions. Countries known in their details are wholly covered with red, and those of which we have a good general knowledge, with red having a slight dash of white. White, with specks of red, indicates countries imperfectly known, while those entirely unknown are left in white. Of course the various shades of red run into each other, but countries unknown and imperfectly known considerably exceed in extent the two other classes, so that there is little danger of exploring and surveying parties wanting work for many years to come. The greater part of Asia and America comes under the two last categories, as also nearly the whole of Africa and Australia; indeed, notwithstanding all that has recently been done in the way of geographical discovery, the white at least balances the red in Malte-Brun's chart.

The same number of the *Bulletin* contains a valuable illustrated paper, by M. L. Chambeyron, giving some details concerning the physical geography of New Caledonia.

The *Geographical Magazine* states that the committee of the statistical section of the Russian Geographical Society appointed to report on a proposition made by MM. Sobolyef and Jansson, to publish a gazetteer of Central Asia, has reported favourably on the subject. They recommend that particular attention be paid to historical geography and ethnology, as statistical data are subject to frequent alterations. The territory to be embraced by the work is bounded on the north by the watersheds of the Ural and Irtysh; on the west coast by the Caspian; on the south by the Elburz, the Hindu Kush, and the Karakorum Range; and in the east by Mongolia. The authorities for every statement made, are to be carefully referred to for future reference, and great care is to be taken with respect to the spelling. A final programme will be laid down by a joint committee of the three sections of the Russian Geographical Society.

The New York *Tribune* of July 10 contains a long article, with many illustrations, on Prof. Hall's magnificent collection of fossils, which, at a cost of $65,000 has been secured for the American Museum of Natural History, at the Central Park, New York.

The Watford Natural History Society has already taken an established place in the first rank of our local societies and field-clubs. It has not been many months in existence, but already have we received the first number of its neatly printed *Transactions*, containing the following papers:—"The Cretaceous Rocks of England," by J. L. Lobley, F.G.S.; "Notes on the Flora of the Watford District," by Arthur Cottam; and "Notes on the proposed Re-issue of the Flora of Hertfordshire, with Supplementary Remarks on the Botany of the Watford District," by R. A. Pryor, F.L.S.

In connection with the Sheffield Ladies Educational Association, Mr. Barrington Ward, F.L.S., has recently concluded a successful and well attended series of elementary lectures on Botany. The results of the examinations on the lectures appear to have been highly satisfactory, and to judge from the specimen examination paper sent us, the questions were well calculated to test the real knowledge of the students.

In Part I. No. 1, for 1875, of the *Journal* of the Asiatic Society of Bengal will be found a very valuable illustrated paper by Major G. E. Fryer, "On the Khyeng People of the Sandoway District, Arakan." Details are given of the habits of the people, with a brief grammar and copious vocabulary of their language.

Mr. G. K. Gilbert's preliminary Geological Report contained in Lieut. Wheeler's Report of the work done by his expedition in 1872 in Nevada, Utah, and Arizona, gives a few interesting data bearing on the former glaciation of N. America. About White's Peak, in the Schell Range, Nevada, are the terminal moraines of five or six glaciers that descended to 8,000 feet altitude in lat. 39° 15′. At about the same altitude, and in lat. 39°, are moraines and an alpine lake upon the flanks of Wheeler's Peak, of the Snake Range, Nevada. Old Baldy Peak (N. lat. 38° 18′), near Beaver, Utah, overlooks two terminal moraines, one of which contains a lakelet at an altitude of about 9,000 feet. No traces were seen of a general glaciation, such as the Northern States experienced, and the cumulative negative evidence is of such weight that Mr. Gilbert is of opinion that the glaciers of the region referred to were confined to the higher mountain-ridges.

The same observer shows that the level of what is now Great Salt Lake must at one time have been much higher and its area much greater than it is at present. Former levels are marked by a series of conspicuous shore-lines carried on the adjacent mountain slopes to a height of more than 900 feet. When the waters rose to the uppermost beach they must have covered an area of about 18,000 square miles, eleven times that of the present lake, and a trifle less than that of Lake Huron; the average depth was 450 feet, and the volume of water nearly 400 times greater than now. The lake was diversified by numerous rocky islands and promontories, and its water was fresh. The flooding of the Great Salt Lake valley, Mr. Gilbert believes, marked a temporary climatal change, and was contemporary with the general glaciation of the northern portion of N. America, and with the formation of the numerous local glaciers of western mountain systems; he considers it a phenomenon of the Glacial Epoch. While the general climatal change that caused or accompanied that epoch (depression of temperature, carrying with it decrease of evaporation, if not increase of precipitation) may be adduced as the cause of the inundation of Utah, Mr. Gilbert sees no reason to suppose that the relative humidities of the various positions of the N. American continent were greatly changed; and this consideration will aid in accounting, he thinks, for the curious fact that the ice in the eastern seaboard stretched unbroken past the fortieth parallel, while under the same latitude in the Cordilleras no glaciers formed below 9,000 feet.

THE third part of the second series of the magnificent work of Mr. William H. Edwards upon the Butterflies of North America has been published by Messrs. Hurd and Houghton, of Cambridge, Massachusetts, and embraces five plates, executed by Miss Mary Peart. The plates represent species of *Papilio*, *Argynnis*, *Apatura*, *Chionobas*, and *Lycæna*; all of them being rare and, for the most part, unfigured species, and also many but recently described.

WE have received the *Journal* of the Anthropological Society for April and July, containing in full the papers which have appeared in abstract in our reports of the meetings of the Society. Many of the papers are of great value, and the illustrations, especially those of the Andamanese, are very interesting.

IT is rumoured that, on the retirement of Sir Henry James from the directorship of the Ordnance Survey, a post which he has filled during a lengthened period with so much distinction, he will be succeeded by Col. A. Ross Clarke. We congratulate the Government on this selection, just at once to a most meritorious officer and to Science and the State. Col. Clarke's eminence as a mathematician and a geodesist are too highly appreciated wherever those sciences are cultivated, both at home and abroad, to need any comment from us.

THE additions to the Zoological Society's Gardens during the past week include a Manatee (*Manatus americanus*) from Demerara, a Ground Hornbill (*Bucorvus abyssinicus*), a White-thighed Colobus (*Colobus bicolor*) from West Africa, a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, deposited; two Jaguars (*Felis onça*) from America, a Squirrel Monkey (*Saimaris sciurea*) from Brazil, purchased; four Amherst Pheasants (*Thaumalea amherstiæ*), a Siamese Pheasant (*Euplocamus prælatus*), and two Vinaceous Doves (*Turtur vinaceus*) bred in the Gardens.

PHYSICAL PROPERTIES OF MATTER IN THE LIQUID AND GASEOUS STATES*

THE investigation to which this note refers has occupied me, with little intermission, since my former communication in 1869 to the Society, "On the Continuity of the Liquid and Gaseous States of Matter." It was undertaken chiefly to ascertain the modifications which the three great laws discovered respectively by Boyle, Gay-Lussac, and Dalton undergo when matter in the gaseous state is placed under physical conditions differing greatly from any hitherto within the reach of observation. It embraces a large number of experiments of precision, performed at different temperatures and at pressures ranging from twelve to nearly three hundred atmospheres. The apparatus employed is, in all its essential parts, similar to that described in the paper referred to; and so perfectly did it act that the readings of the cathetometer, at the highest pressures and temperatures employed, were made with the same ease and accuracy as if the object of the experiment had been merely to determine the tension of aqueous vapour in a barometer-tube. In using it the chief improvement I have made is in the method of ascertaining the original volumes of the gases before compression, which can now be know with much less labour and greater accuracy than by the method I formerly described. The lower ends of the glass tubes containing the gases dip into small mercurial reservoirs formed of thin glass tubes, which rest on ledges within the apparatus. This arrangement has prevented many failures in screwing up the apparatus, and has given more precision to the measurements. A great improvement has also been made in the method of preparing the leather-washers used in the packing for the fine screws, by means of which the pressure is obtained. It consists in saturating the leather with grease by heating it *in vacuo* under melted lard. In this way the air enclosed within the pores of the leather is removed without the use of water, and a packing is obtained so perfect that it appears, as far as my experience goes, never to fail, provided it is used in a vessel filled with water. It is remarkable, however, that the same packing, when an apparatus specially constructed for the purpose of forged iron was filled with mercury, always yielded, even at a pressure of forty atmospheres, in the course of a few days.

It is with regret that I am still obliged to give the pressures in atmospheres, as indicated by an air- or hydrogen manometer, without attempting for the present to apply the corrections required to reduce them to true pressures. The only satisfactory method of obtaining these corrections would be to compare the indications of the manometer with those of a column of mercury of the requisite length; and this method, as is known, was employed by Arago and Dulong, and afterwards in his classical researches by Regnault, for pressures reaching nearly to thirty atmospheres. For this moderate pressure a column of mercury about 23 metres, or 75 feet, in length had to be employed. For pressures corresponding to 500 atmospheres, at which I have no difficulty in working with my apparatus, a mercurial column of the enormous height of 380 metres, or 1,250 feet, would be required. Although the mechanical difficulties in the construction of a long tube for this purpose are perhaps not insuperable, it could only be mounted in front of some rare mountain escarpment, where it would be practically impossible to conduct a long series of delicate experiments. About three years ago I had the honour of submitting to the Council of the Society a proposal for constructing an apparatus which would have enabled any pressure to be measured by the successive additions of the pressure of a column of mercury of a fixed length; and working drawings of the apparatus were prepared by Mr. J. Cumine, whose services I am glad to have again this opportunity of acknowledging. An unexpected difficulty, however, arose in consequence of the packing of the screws (as I have already stated) not holding when the leather was in contact with mercury instead of water, and the apparatus was not constructed. For two years the problem appeared, if not theoretically, to be practically impossible of solution; but I am glad now to be able to announce to the Society that another method, simpler in principle and free from the objections to which I have referred, has lately suggested itself to me, by means of which it will, I fully expect, be possible to determine the rate of compressibility of hydrogen or other gas by direct reference to the weight of a liquid column, or rather of a number of liquid columns, up to pressures of 500 or even 1,000 atmospheres. For the present it must be understood that, in stating the following results, the pressures in atmospheres are deduced from the apparent compressibility, in some cases of air, in others of hydrogen gas, contained in capillary glass tubes.

In this notice I will only refer to the results of experiments upon carbonic acid gas when alone or when mixed with nitrogen. It is with carbonic acid, indeed, that I have hitherto chiefly worked, as it is singularly well adapted for experiment; and the properties it exhibits will doubtless, in their main features, be found to represent those of other gaseous bodies at corresponding temperatures below and above their critical points.

Liquefaction of Carbonic Acid Gas.—The following results have been obtained from a number of very careful experiments, and give, it is believed, the pressures, as measured by an air-manometer, at which carbonic acid liquefies for the temperatures stated:—

Temperatures in Centigrade degrees.	Pressure in atmospheres.
0	35·04
5·45	40·44
11·45	47·04
16·92	53·77
22·22	61·13
25·39	65·78
28·30	70·39

I have been gratified to find that the two results (for 13°·09 and 21°·46) recorded in my former paper are in close agreement with these later experiments. On the other hand, the pressures I have found are lower than those given by Regnault as the result of his elaborate investigation (*Mémoires de l'Academie des Sciences*, vol. xxvi. p. 618). The method employed by that distinguished physicist was not, however, fitted to give accurately the pressures at which carbonic acid gas liquefies. It gave, indeed, the pressures exercised by the liquid when contained in large quantity in a Thilorier's reservoir; but these pressures are always considerably in excess of the true pressures in consequence of the unavoidable presence of a small quantity of compressed air, although the greatest precautions may have been taken in filling the apparatus. Even $\frac{1}{500}$ part of air will exercise a serious disturbing influence when the reservoir contains a notable quantity of liquid.

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* "Preliminary Notice of further Researches on the Physical Properties of Matter in the Liquid and Gaseous States under varied conditions of Pressure and Temperature." Paper read before the Royal Society by Dr. Andrews, F.R.S., Vice-President of Queen's College, Belfast.

Law of Boyle.—The large deviations in the case of carbonic acid at high pressures from this law appeared distinctly from several of the results given in my former paper. I have now finished a long series of experiments on its compressibility at the respective temperatures of 6°·7, 63°·7, and 100° Centigrade. The two latter temperatures were obtained by passing the vapours of pyroxylic spirit (methyl alcohol) and of water into the rectangular case with plate-glass sides, in which the tube containing the carbonic acid is placed. The temperature of the vapour of the pyroxylic spirit was observed by an accurate thermometer, whose indications were corrected for the unequal expansion of the mercury; while that of the vapour of water was deduced from the pressure as given by the height of the barometer and a water-gauge attached to the apparatus. At the lower temperature (6°·7) the range of pressure which could be applied was limited by the occurrence of liquefaction; but at the higher temperatures, which were considerably above the critical point of carbonic acid, there was no limit of this kind, and the pressures were carried as far as 223 atmospheres. I have only given a few of the results; but they will be sufficient to show the general effects of the pressure. In the following Tables p designates the pressure in atmospheres as given by the air-manometer, t' the temperature of the carbonic acid, ϵ the ratio of the volume of the carbonic acid under one atmosphere and at the temperature t' to its volume under the pressure p' and at the same temperature, and θ the volume to which one volume of carbonic acid gas measured at 0° and 760 millimetres is reduced at the pressure p and temperature t':—

Carbonic Acid at 6°·7.

p.	t'.	ϵ.	θ.
at.	°		
13·22	6·90	$\frac{1}{14\cdot36}$	0·07143
20·10	6·79	$\frac{1}{23\cdot01}$	0·04456
24·81	6·73	$\frac{1}{29\cdot60}$	0·03462
31·06	6·62	$\frac{1}{39\cdot57}$	0·02589
40·11	6·59	$\frac{1}{58\cdot40}$	0·01754

Carbonic Acid at 63°·7.

p.	t'.	ϵ.	θ.
at.	°		
16·96	63·97	$\frac{1}{17\cdot85}$	0·06931
54·33	63·57	$\frac{1}{66\cdot06}$	0·01871
106·88	63·75	$\frac{1}{185\cdot9}$	0·00665
145·54	63·70	$\frac{1}{327\cdot3}$	0·00378
222·92	63·82	$\frac{1}{446\cdot9}$	0·00277

Carbonic Acid at 100°.

p.	t'.	ϵ.	θ.
at.	°		
16·80	100·38	$\frac{1}{17\cdot33}$	0·07914
53·81	100·33	$\frac{1}{60\cdot22}$	0·02278
105·69	100·37	$\frac{1}{137\cdot1}$	0·01001
145·44	99·46	$\frac{1}{218\cdot9}$	0·00625
223·57	99·44	$\frac{1}{380\cdot9}$	0·00359

These results fully confirm the conclusions which I formerly deduced from the behaviour of carbonic acid at 48°, viz. that while the curve representing its volume under different pressures approximates more nearly to that of a perfect gas as the temperature is higher, the contraction is nevertheless greater than it would be if the law of Boyle held good, at least for any temperature at which experiments have yet been made. From the foregoing experiments it appears that at 63°·7 carbonic acid gas, under a pressure of 223 atmospheres, is reduced to $\frac{1}{447}$ of its volume under one atmosphere, or to less than one half the volume it ought to occupy if it were a perfect gas and contracted in conformity with Boyle's law. Even at 100° the contraction under the same pressure amounts to $\frac{1}{381}$ part of the whole. From these observations we may infer by analogy that the critical points of the greater number of the gases not hitherto liquefied are probably far below the lowest temperatures hitherto attained, and that they are not likely to be seen, either as liquids or solids, till much lower temperatures even than those produced by liquid nitrous oxide are reached.

(*To be continued.*)

NEW METHOD OF OBTAINING ISOTHERMALS ON THE SOLAR DISC*

On June 5, 1875, I devised a method for obtaining the isothermals on the solar disc. As this process may create an entirely new branch of solar physics, I deem it proper that I should give a short account of it in order to establish my claim as its discoverer.

In the American Journal, July 1872, I first showed how one can, with great precision, trace the progress and determine the boundary of a wave of conducted heat in crystals, by coating sections of these bodies with Meusel's double iodide of copper and mercury, and observing the blackening of the iodide where the wave of conducted heat reaches 70° C. If we cause the image of the sun to fall upon the smoked surface of thin paper, while the other side of the paper is coated with a film of the iodide, we may work on the solar disc as we formerly did on the crystal sections.

The method of proceeding is as follows: beginning with an aperture of object-glass which does not give sufficient heat in any part of the solar image to blacken the iodide, I gradually increase the aperture until I have obtained that area of blackened iodide which is the smallest that can be produced with a well-defined contour. This surface of blackened iodide I call the *area* of blackened temperature. On exposing more aperture of object-glass, the surface of blackened iodide extends and a new area is formed bounded by a well-defined isothermal line. On again increasing the aperture another increase of blackened surface is produced with another isothermal contour; and on continuing this process I have obtained maps of the isothermals of the solar image. By exposing for about twenty minutes the surface of iodide to the action of the heat inclosed in an isothermal, I have obtained thermographs of the above areas; which are sufficiently permanent to allow one to trace accurately their isothermal contours. There are other substances, however, which are more suitable than the iodide for the production of permanent thermographs.

The contours of the successively blackened areas on the iodide are *isothermals*, whose successive thermometric values are inversely as the successively increasing areas of aperture of object glass which respectively produced them.

As far as the few observations have any weight, the following appear to be the discoveries already made of this new method. (1) There exists on the solar image an area of sensibly uniform temperature and of maximum intensity. (2) This area of maximum temperature is of variable size. (3) This area of maximum temperature has a motion on the solar image. (4) The area of maximum temperature is surrounded by well-defined isothermals marking successive gradations of temperature. (5) The general motions of translation and of rotation of these isothermals appear to follow the motions of the area of maximum temperature which they inclose; but both central area and isothermals have independent motions of their own.

On projecting the enlarged image of a sun-spot on the blackened surface and then bringing a hot-water box, coated with lamp-black, near the other side of the paper, one may

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* The discovery of a method of obtaining Thermographs of the Isothermal Lines of the Solar Disc, by Alfred M. Mayer in Silliman's *American Journal* for July.

develop the image of the spot in *red* on a dark ground. A similar method probably may serve to develop the athermic lines in the ultra-red region of the solar and other spectra.

OUR BOTANICAL COLUMN

Ferula Alliacea.—The late Mr. D. Hanbury was a valuable and frequent contributor to the Kew Museums, and the very last contribution made, or rather bequeathed by him, has a scientific as well as a melancholy interest. The specimen in question was a fine umbel, bearing ripe fruits of *Ferula alliacea*, Boiss., the label to which we believe was written at his dictation just before his death. Seeds of this plant were also received at Kew from him some time before the receipt of this specimen, and these have germinated, and, though healthy, are as yet naturally very small plants. In the "Pharmacographia" Mr. Hanbury refers to this plant as exhaling a strong odour of Asafœtida, but says it is not known as the source of any commercial product. In contradistinction of this, however, Mr. W. Dymock, Professor of Materia Medica at Bombay, writing on the Asafœtidas of the Bombay market in a recent number of the *Pharmaceutical Journal*, says that this plant produces one of the distinct kinds known in the above drug market under the name of "Abushaheree Hing," and is brought from the Persian Gulf ports, principally from Abushaher and Bunder Abbas, and is produced in Khorassan and Kirman. The specimens received at Kew from Mr. Hanbury appear to have been first received by him from the author of the paper in question, for he refers to having sent such specimens; therefore, if the specimens are authentic, there is no reason to doubt the truth of the statement made by Mr. Dymock, that the drug which appears in the Bombay Customs Returns as Hing or Asafœtida, is produced by this plant. It arrives in Bombay either in skins sewn up so as to form a flat oblong package, or in wooden boxes. Its appearance varies according to age, being soft, and about the thickness of treacle when quite fresh, and of a dull olive brown colour and a pure garlic odour. It becomes hard and translucent and of a yellowish brown colour after being kept some time. Slices of the root are found mixed with the resin in about equal proportion. In 1872–73 as many as 3,367 cwt. of this drug were imported into Bombay from the Persian Gulf. The information given in the paper from which we have quoted the above particulars seems to be of a trustworthy nature, and will prove a valuable addition to what we already know of the Asafœtidas.

Diverse Effects of the same Temperature on the same Species in Different Latitudes.—In the *Comptes Rendus des Séances de l'Académie des Sciences*, June 1875, Mr. A. de Candolle gives the results of some experiments instituted by himself last winter to determine the degree of influence of heat on the vegetation of the same species under otherwise diverse conditions. The sudden burst into life and the rapid development of the vegetation of northern regions is proverbial; the advent of mild weather seems to bring at once into activity the accumulated vital energies, and growth is exceedingly rapid. In the south the same temperature would have far less visible effect on the same species. De Candolle has attempted by direct experiment to ascertain to what extent this influence is exercised. For this purpose he procured specimens of several common deciduous trees from Montpellier, and submitted them to the same temperature as, and with, specimens of the same species collected at Geneva. In the ordinary course of things the same species came into leaf from three weeks to a month earlier at Montpellier than at Geneva, but the specimens from the south, by the side of the northern specimens, did not unfold their leaves so early as the latter by about three weeks. The White Poplar Hornbeam and Tulip Tree were the principal trees employed. Catalpa, a very late leafing subject, exhibited less diversity in this respect. This phenomenon is equally striking in cereals and other cultivated plants. The learned author attributes these differences in effect mainly to the fact that vegetation, or external growth, never entirely ceases in the south, whereas in the north there is a long period during which internal changes and modifications of substances alone is carried on.

SCIENTIFIC SERIALS

The American Journal of Science and Art, July.—The original articles are:—On the United States Weather Map, by E. Loomis, which we have already noticed.—On a magnetic proof plane, by H. A. Rowland. The apparatus required is a small coil of wire ¼ to ½ inch in diameter and containing 10 to 50 and a Thomson galvanometer. Having attached the small coil (or magnetic proof plane, as Mr. Rowland calls it) to the galvanometer, it has to be laid on the required spot and then suddenly pulled away and carried to a distance, and the momentary deflection of the galvanometer will be proportional to that component of the lines of force at that point which is perpendicular to the plane of the coil. By a coil of this kind it is possible to determine the intensity of the magnetic field at any point, and thus be able to make a complete map of it. Illustrations of the method are given.—On pseudomorphs of chlorite after Garnet at the Spurr Mountain Iron Mine, Lake Superior, by Raphael Pumpelly, with a coloured plate of a section magnified $\frac{22}{1}$.—A brief note on the application of the horizontal pendulum, by Harcourt Amory.—Explosive properties of methyl nitrate, by Carey Lea. This communication describes a new method and the requisite apparatus for preparing it, so that danger is reduced to a minimum.—On zonochlorite and chlorastrolite, by G. W. Hawes.—On glycogen and glycocoil in the muscular tissue of *Pecten irradians*. The glycogen has the formula of the sugars of that of the starch group plus a molecule of water. The amount of glycocoil occurring in the tissue is small. Analyses are given.—On Dr. Koch and the Missouri mastodon, by Edmund Andrews. The object of the article is to show that Dr. Koch's testimony contributes nothing reliable on the question of the occurrence of human remains in conjunction with the mastodon.—On the rate of growth of corals, by Prof. Joseph Le Conte. Examining a grove of madrepores he noticed that all the prongs grew to the same level, which at the time were very near the surface; and that all of them were dead at the tips for about three inches. The varying level of the ocean at the place is known from the Coast Survey Report, and as it seems that during the high water the madrepores *grow* up, the living points of the madrepores grow up till the descending water-level exposes and kills them down to a certain level; with the rise of the mean level again new points start upwards. The annual growth, calculated from the known rise and fall of water level, is from 3½ to 4 inches per annum.—Results of dredging expeditions off the New England Coast in 1874, by A. E. Verrill. Lists of species are given.—Examination of gases from the meteorite of Feb. 12, 1875, by A. W. Wright.—Discovery of two new asteroids, 144 and 145, by C. H. Peters. The diameter of 144 is as the 10th, and 145 as 11·5.—The discovery of a method of obtaining thermographs of the isothermal lines of the solar disc, by Alfred M. Mayer. We reprint the paper this week.

Jahrbücher für wissenschaftliche Botanik. Herausgegeben von Dr. N. Pringsheim. Band x. Heft. 1. (Leipzig, 1875).—In the first part of the tenth volume of Pringsheim's well-known *Jahrbuch* we have three papers all of very considerable importance. The first is a translation of Count Francesco Castracane's paper on the Diatomaceæ of the Carboniferous period. Ashes of coal from Liverpool yielded, on microscopic examination, several species of Diatomaceæ. The chief forms identified by Count Castracane all belong to fresh-water genera and species, viz.:—

Fragilaria Harrisonii. Sm.
Epithemia gibba. Ehrbg.
Sphenella glacialis, Kz.
Gomphonema capitatum, Ehrbg.
Nitzschia curvula, Kz.
Cymbella Scotica, Sm.
Synedra vitrea, Kz.
Diatoma vulgare, Bory.

In addition to these there existed a Grammatophora, a small Coscinodiscus, and probably an Amphipleura (*danica?*). These three marine forms were only observed on one occasion, and their presence must have indicated some accidental inroad of sea-water among the vegetation from which the piece of coal was formed. All the fresh-water forms which occurred in the coal are not to be distinguished from the living forms of the same species, a fact of great interest and importance, as it indicates the remarkable permanence of these forms in time; and it is probably an unique instance of the occurrence of species which have remained unmodified through all the lapse of ages which separates the present epoch from the coal period. Count Castracane examined other varieties of coal besides that obtained from near Liverpool, viz., coal from the mines at St. Etienne, another from Newcastle, and a third specimen of the Scotch "Cannel coal." In all these *fresh-water* diatoms were found to be more or less numerous. The three specimens yielded different species of Diatomaceæ, but no new forms were detected. The coal for examination was finely pulverised, then placed in a piece of combustion tubing and heated to redness, a gentle stream of oxygen being passed over the substance. The temperature must not be raised too high, in order not to fuse the siliceous skeletons of the Diatomaceæ. The residue is to be treated with nitric acid and chlorate of potash, and heated, then washed carefully with distilled water, and mounted in the usual way. The examination of other varieties of coal would no doubt yield results of the highest interest and importance.—The second paper, "Beiträge zur Theorie der Pflanzenzelle," is by Dr. J. Tschistiakoff, and is devoted to the development of the pollen of *Epilobium augustifolium*. The chief point in the paper is the description of the pro-nucleus, which is also to be met with, according to Tschistiakoff, in the spores of Cryptogams. In the mother-cells of the pollen-grains the protoplasm becomes differentiated into certain zones or regions, one called the pro-nucleus, which contains the nucleolus. The pro-nucleus becomes more differentiated during the growth of the cell, and may divide or disappear. When new pro-nuclei are formed, one ultimately becomes developed into the true nucleus of the cell. The paper is illustrated by five plates.—The last paper is upon the development of the Prothallium of the Cyatheaceæ, by Dr. Hermann Bauke. The species chiefly examined were: *Cyathea medullaris*, *Alsophila australis*, and *Hemitelia spectabilis*. The paper treats of—1. The germination of the spore and the development of the Prothallium; 2. The development of the Antheridia; 3. Development of the Archegonia and Fertilisation; 4. Male Prothallia and proliferation of Prothallia; and 5. Anomalies. The general results of the paper show that in most points the development of the Prothallium of the Cyatheacæ agrees with that of the Polypodiaceæ. A special peculiarity is the occurrence of one rarely of two, stalk-like cells to the Antheridium. The subject is exhaustively treated, and it is illustrated by five plates.

Reichert und Du Bois-Reymond's Archiv für Anatomie, Physiologie, &c., 1875. No. 1, May.—On the Pronation and Supination of the forearm, by Hermann Welcker, Halle. The author believes that the motions of pronation and supination should be regarded not merely as movements of rotation, but also as hinge-movements about an axis passing through the middle of the head of the radius and the styloid process of the ulna. For the term "extreme supination" he would substitute dorsal flexion of the radius; for "pronation," volar flexion of the radius. The actions and positions of the muscles concerned are carefully analysed, and diagrams are given illustrating and supporting the view taken.—Another paper by the same author discusses the effect of the ileo-tibial tract of the fascia lata.—In a paper on the partial excitation of nerves, Hermann Munk gives a *résumé* of his previous papers on the various effects produced on the fibres of nerves according to their situation with respect to the electrodes used, and attributes the contradictory results attained by Rollett and Bour, who believe in a difference of functional irritability in different nerve-fibres, to their having used induction-currents, while he had used constant currents in his experiments.—Dr. Dönhoff points out that calves born early in the year have a longer and thicker coat of hair than those born later in the season; and that this occurs indifferently whether the mother is kept in the stall all the year round, or only passes the winter in the stall.—Dr. Wenzel Gruber, of St. Petersburg, describes a case of the occurrence of the lateral tuberosity of the fifth metatarsal bone as a distinct epiphysis, and two cases of epiphyses on the tubercle of the trapezium.—Dr. von Ihering, in a paper on the temporal ridges of the human skull, supports Hyrtl's description of two temporal ridges, of which one or other is usually better developed. He comes to the conclusion that the upper ridge is related to the temporal fascia, and the lower to the limit of the temporal muscle, and that the temporal ridges in man correspond accurately with those of the anthropomorphic apes. He figures skulls of a Paumotu Islander and of a Hungarian in the Göttingen Museum, as instances of remarkably prominent temporal ridges.—Dr. Albert Adamkiewicz, of Königsberg, contributes a remarkable paper on the analogies to Dulong and Petit's Law of Specific Atomic Heat in Animal Temperature. He conducted an elaborate series of experiments to determine the influence of the surrounding temperature and the size of the body on the specific temperature of the animal, and to discover the physical explanation of the results attained by physiological experiments on temperature. The paper extends over nearly seventy pages, and it is impossible here to do more than indicate the subject of inquiry.

No. 2, July.—This number, in addition to the conclusion of the last-named paper, contains another by Dr. Adamkiewicz on the conductivity of muscle for heat. The conclusion drawn from experiment is that on a scale representing the conductivity of copper as 1000, water as 1·4, and that of air as 0·05, the conductivity of muscle is represented by 0·6.—J. Steiner, of Halle, gives the results of experiments with curare on fishes, newts, molluscs, starfishes, holothurians, and medusæ. He finds that in fishes there is paralysis of the central organ of voluntary motion, of the respiratory centre, and of motor nerves, and that the times at which the effects appear are in the order named. The period at which paralysis of motor nerves sets in, is much later than in higher vertebrates. In the electrical rays the power of the electrical nerves remains much longer than that of motor nerves. In crabs the phenomena are similar to those in fishes, but they appear still later. In molluscs, starfishes, and holothurians, there is only a paralysis of the central organ of voluntary motion. Curare appears to have no effect on medusæ.—Fanny Berlinerblau describes a case of direct transition from arteries to veins in the human subject.—E. Tiegel gives an account of the physiological effect of a capillary electrical current.—Dr. W. Gruber has four papers—(1) on the occurrence of a second zygomatic bone in man; (2) on the piso-hamatus muscle; (3) on an anomalous extensor digitorum communis in the hand, and a similar anomaly in the extensor digitorum longus in the foot; and (6) on the flexor pollicis longus.—W. Krause figures a human embryo at about the fourth week, with a pear-shaped allantois.—E. Meyer gives an account of comparative investigations in the mammalia on the cause of the pale or red appearance of striated muscles, and concludes that the shade of colour varies with the work done by them.—Prof. Aeby, of Berne, has a paper on the sesamoid bones of the human hand.

THE *Geographical Magazine*, August.—In connection with Lieut. Cameron's explorations, Mr. C. R. Markham takes occasion to give an interesting *résumé* of the history of the discovery of the course of the Congo, and strongly advocates that relief should be sent out to Cameron.—An interesting sketch follows of the journey of Chekanovski and Müller to the Siberian river Olena (Olenek), in 1873–74; this is illustrated by a sketch-map.—The number also contains a large sketch-map of the countries between Kashmir and Panjkirah, including Chilas, Kandia, and other districts of Dardistan, compiled by Mr. Ravenstein from the most trustworthy recent sources.—"Sign-posts on Ocean's Highway.—The Physical Education of Dust.—Mountains," is the title of an article by Mr. H. P. Malet.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, April 1.—On cold mixtures, with special reference to those consisting of snow and sulphuric acid, by Prof. Pfaundler.—On palæogeological geography, by Dr. A. Boué.—On the carboniferous lime fauna of the Barents Isles (in the N.W. of Novaya Zemlya), by Dr. F. Toula; this interesting paper contains a list of no less than one hundred different species found in that remote locality.

April 15.—The following papers were read:—On anomalous dispersion, by Prof. E. Mach.—On a new direct proof for the rotation of the earth, by F. v. Sedlmayer Seefeld.—On the generating of nitrogen from the albuminoid matter undergoing assimilation in the body, by Prof. J. Seegen and Dr. Nowak.—On an apparatus for the determination of the mechanical equivalent of heat, by H. J. Puluj.—On the orbit of Planet (III.) Ate, by Director von Littrow and Dr. Holetschek.—On the variability of diurnal temperatures, by Dr. J. Hann.—On the function of lime with germ-plants of *Phaseolus multiflorus*, by Prof. J. Boehm.—Several papers of minor interest.

BERLIN

German Chemical Society, July 12.—A. W. Hofmann in the chair.—A. Borodin, in treating an amarine salt with nitrite of potassium, has obtained a nitrosoamarine. He concludes amarine to be an imidobase.—A. Michaëlis and F. Graeff have discovered a new mode of formation of phosphenylic chloride, by treating diphenylmercury with terchloride of phosphorus:

$$PCl_3 + Hg(C_6H_5)_2 = PCl_2C_6H_5 + HgClC_6H_5.$$

J. V. Janowsky published new analyses of the mineral Cronstedtite.—A. Kundt and E. Warburg have investigated the specific heat of the vapour of mercury. Their reason for doing so was the exception shown by most vapours with regard to the kinetic molecular theory of Clausius. If c signifies the specific heat of a gas of constant volume, and c' the specific heat of the same gas at constant pressure: then $\frac{c'}{c}$ according to that theory should be $= 1{\cdot}67$, while most gases have been found to possess the coefficient $= 1{\cdot}405$. Mercury-vapour affords a particular interest, because its molecule is monatomic compared with those diatomic volumes of most other gases. It was found to coincide with the law of Clausius $\frac{c'}{c}$ having been found 1·67.—A. Schüller and V. Wartha described a new ice-calorimeter, a modification of Bunsen's instrument which offers the facility of applying ice which is not entirely pure.—F. Beilstein, as also A. Claus, described derivations of dichlorobenzoic acid.—R. Gnehm described derivatives of diphenyl-amine.—V. Meyer and Lecco have treated iodide of tetramethyl-ammonium with iodide of ethyl, and also iodide of tetraethylammonium with iodide of methyl, without observing in either case an exchange of ethyle against methyl.—W. Klobukowsky and E. Nölting have made researches respecting the constitution of rufigallic acid, which lead them to adopt the formula formerly described by M. Jaffé.—Ph. Zöller and E. A. Grete have added some new observations on xanthogenic salts as a remedy against Phylloxera. Amylic xanthogenate appears to be as efficacious as the corresponding ethylxanthogenate. Amylxanthogenate of potassium can be prepared in Vienna at the price of 3*l.* a hundredweight.—C. Liebermann has submitted emodine, the substance accompanying chrysophanic acid in the root of rhubarb, to new researches. He considers it as methylpurpurine—

$$C_{14}H_7\left\{\begin{array}{l}CH_3\\(OH)_3\\O\\O\end{array}\right.$$

By oxydation it yields anthrachinone-carbonic acid—

$$C_{14}H_7(CO_2H)(OH)_3(O_2)''.$$

Heated with powdered zinc, emodine yields anthracene.—C. Liebermann and E. Fischer have transformed purpurine into amidoalizarine—

$$C_{14}H_6\left\{\begin{array}{l}OH\\(OH)_2\\O_2\end{array}\right. + NH_3 = H_2O + C_{14}H_6\left\{\begin{array}{l}NH_2\\(OH)_2\\O_2\end{array}\right.$$

This body, by the action of nitrous acid, gives an isomerid of alizarine, viz., purpuroxanthine.—A. Pinner found chloracrylic acid to be transformed by water into malonic acid.—H. Gabriel has studied the body called ammelide by Gerhardt, and has found the formula $(C_3N_3)NH(OH)_2$ predicted by this chemist.—P. Meyer has prepared a number of derivatives of glycocoll, containing phenyl or tolyl and chlorine, obtained by the action of aniline and toluidine on the chloride of chloracetic acid. He likewise has studied the action of those bases on the ether of chloracetic acid.—C. L. Jackson has found in the residues of aniline obtained from a German manufactory a base homologous with xenylamine, viz., $C_{13}H_{13}N = C_{13}H_{11}NH_2$. The radical being most likely, tolylphenyl.

PARIS

Academy of Sciences, Aug. 2.—M. Frémy in the chair.—The following papers were read:—On the magnets formed of compressed powders, by M. J. Jamin.—Memoir by M. N. Joly, entitled: A gap in the teratological series filled up by the discovery of the genus "Ileadelphia."—On neutral substrata, by M. Weddell. This paper relates to another one read by M. Contejean at the meeting of July 19, with reference to botanical geography.—A critical examination of the basis upon which the calculus generally used to estimate the stability of bridges with metal supports and straight prismatical beams, is based; with propositions for the adoption of a new basis, by M. Lefort.—On the integration of an equation with partial differentials of the second order, by M. N. Nicolaides.—On the recurrent sensibility of the peripherical nerves of the hand, by M. A. Richet.—Researches on the nodules of oligoclase in the lava of the last eruption of Santorin, by M. F. Fouqué.—On the method of buying beetroot by the density of their juice, by M. Durin.—On microzymata and their functions in the different ages of one and the same being, by M. J. Bechamp.—A new process for the determination of free oxygen in urine, by M. D. Freire.—Observations by M. Blanchet, on the project of creating a sea in the interior of Africa.—A memoir by M. P. Maille, on cyclones. On the variations in the brilliancy of Jupiter's fourth satellite, with deductions regarding its physical constitution and its movement of rotation, by M. Flammarion. The author states the following results of his observations: The IV. satellite of Jupiter undergoes considerable variations in its brilliancy and appears to us as a star between the 6th and the 10th magnitudes. As its phases as seen from the earth are hardly perceptible, we conclude that its physical constitution is absolutely different from that of the moon. There is a probability (but no certainty) in favour of the hypothesis that it revolves like the moon, presenting always the same face to the planet. In that case, its brightest hemisphere would be that which it turns towards the sun when on the superior western quarter of its orbit, and its darkest hemisphere the one it turns towards the sun when it stands in the lower eastern quarter of its course. This hypothesis does not account for all the variations observed, and this little world seems to undergo atmospherical revolutions which cause its reflecting surface to vary at any point of its orbit. It appears sometimes nebulous and dim. Its reflecting power is as a rule inferior to that of the three other satellites of Jupiter.—On molecular combinations by M. C. Friedel.—On the complete separation of arsenic from animal matter and on its determination in the different tissues, by M. Arm. Gautier.—On the determination of glucose in wine, by M. A. Bechamp.—On the breaking off of the teats of guinea-pigs, by M. de Sinety.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Proceedings of the Liverpool Naturalists' Field Club, 1874-75.—The Celt, the Roman and the Saxon: Thos. Wright, F.S.A. 3rd edition, revised (Trübner and Co.)—Proceedings of the Bristol Naturalists' Society, N.S., Vol. i. Part 2.—Jenkinson's Practical Guide to Carlisle, Gilsland, Roman Wall, &c. (Stanford); and smaller edition of above.—Rocket Floats and Rocket Rams: Chas. Meade Ramus (Stanford).—A Practical Treatise on the Diseases of the Eye: Haynes Walton, F.R.C.S. (J. and A. Churchill).—The Annual Address of the Victoria Institute: Rev. Robert Main (Hardwicke).—Our Summer Migrants: J. E. Harting, F.L.S., F.Z.S. (Bickers and Son).

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THURSDAY, AUGUST 19, 1875

THE SCIENCE COMMISSION REPORT ON THE ADVANCEMENT OF SCIENCE

IN our last issue we published the substance of the Eighth and final Report of the Royal Commission on Science, presided over by the Duke of Devonshire, which includes the measures deemed by that body necessary for the advancement of science in England.

We now propose to lay before our readers a summary of the evidence on the above branch of the investigation undertaken by the Commission. It must be borne in mind that the evidence given on this topic fills a Blue Book of more than 400 closely printed pages, and the extracts from it with which the Commissioners fortify the Report now under notice fill some forty pages. These extracts have been selected with obvious impartiality. The further compression which it must undergo in order to fit it for our columns must necessarily weaken the force of the testimony borne by a cloud of able witnesses. All we can hope to do, within our limits, is to give an idea of some of the salient points established, and of the general tendency of the whole.

Adhering to the subdivision, adopted by the Commission, under four principal heads, we proceed to

I.—*The Scientific Work carried on by Departments of the Government.*

The following enumeration of State Scientific Institutions now existing, together with that of the various Departments responsible for them, is given on the authority of the Royal Commission :—

Topographical Survey [Treasury (Office of Works)].
Hydrographical Survey [Admiralty].
Geological Survey [Privy Council].
Astronomical Observations :—
  Greenwich and the Cape of Good Hope [Admiralty].
  Edinburgh [Treasury (Office of Works)].
Meteorological Observations :—
  Greenwich [Admiralty].
  Edinburgh [Treasury (Office of Works)].
  The Meteorological Office.
    [The Meteorological Office is not administered by any Public Department, but is directed by a Committee, which, although appointed by the Royal Society, is independent of that body.]
Botany.—Royal Gardens, Kew ; Botanic Garden, Edinburgh ; Botanic Gardens, Dublin [Treasury (Office of Works)].
The Chemical Department of the War Office.
The Standards Department of the Board of Trade.

Analogous work is carried on in some of the colonies and foreign possessions by departments of their respective Governments.

In one case, that of the Royal Observatory, Greenwich, the work is examined into and reported on to the Admiralty by a Board of Visitors composed of men of science.

This extraordinary list is substantially that with which Col. Strange opened his evidence as the foundation on which the present demands for reform must be based. It establishes conclusively three most important points. (1) That the State does, and therefore should, actively aid scientific research. (2) That it does so partially, many essential branches being without aid. (3) That a divided administration such as this list of six or seven departments concerned with science indicates, cannot possibly secure harmony, systematic efficiency, or the extension which, as knowledge and the wants of the nation advance, may be requisite.

The Commissioners then add the following statement, showing the annual charges borne by imperial funds, at the present time, to defray the expenses of such of these various investigations as appear separately in the Estimates for the year 1874-75 :—

Topographical Survey (excluding military pay of men employed)	£132,000
Hydrographical Survey	121,055
Geological Survey	22,920
Astronomy	9,703
Meteorology	12,082
Botany, including the maintenance of Botanical Gardens as places of public recreation	21,470
Standards Department of the Board of Trade	2,063

In addition to these recurring charges, sums are voted from time to time for various expeditions and for experiments incidental to the services of the various departments, such as the investigations concerning the causes and processes of disease carried on under the direction of the Lords of the Privy Council, and the various experimental researches carried on for the army and navy.

Even if no questions of completeness or extension were raised, the fact of an expenditure, reaching probably about half a million annually, without any pretence of a system to regulate it, is one in itself deserving very serious consideration.

As to the insufficiency of our present administrative arrangements, we have valuable evidence from several Government officials and gentlemen engaged in national works.

Sir Henry Rawlinson, a member of the Indian Council, states that in that Council they perpetually have references before them which they are unable to deal with. He adds :—

> ". . . We have, for instance, Sir William Baker upon the Council, and General Strachey and Colonel Strange, both attached to the office ; yet, notwithstanding their valuable aid, there are many subjects referred to us with which we are quite incompetent to deal."

He then refers to the following subjects among others :—The Manufacture of Iron and Steel in India ; the Efflorescence of Soda on Irrigated Land ; the Fermentation of Beer, "which may involve a loss of 200,000*l.* or 300,000*l.* a year to the British Government ;" the question of Drought arising from the Destruction of Forests ; the Construction of Harbours and of other Hydraulic Works ; the Founding of Brass Guns ; Tidal Observations ; the Publication of Works on the Flora and Fauna of India ; Geological and Trigonometrical Surveys ; Sea Dredging ; and Observatories.

He points out that many of these questions are practical and economical, but that still there is a scientific element in almost all of them, and he adds :—

> "References on all these subjects are constantly coming home, and we have no means of answering them in our own body, while it is very unsatisfactory to be obliged to

send out for gratuitous information. We do sometimes, it is true, apply to individuals and sometimes to societies, but in very many cases, I am afraid, the questions are shelved, because there is no competent and authoritative body to refer to."

Capt. Douglas Galton, of the Office of Works and Public Buildings, thinks that, as a rule—

". . . Our statesmen do not appreciate properly the value of scientific advice or scientific inquiry, and that they are very much fonder of experiments made upon a large scale with no defined system, than they are of experiments which have been brought out as the result of a carefully studied previous inquiry. I think that an enormous amount of money was wasted in the case of the inquiry into armour plates, both for ships and forts. In that case the Government appointed a partly scientific committee, but it was mixed up with other persons who were not scientific; and instead of commencing a series of experiments upon a small and clearly defined scale, from which they could have drawn conclusions for making their larger experiments, they began by firing at any plates that were offered to them which had no relation one to another, either in their relations to the guns or to the form of backing, or in any other way, and consequently it was difficult to draw useful calculations from them."

Mr. Froude, who was a prominent member of the late Committee on Naval Designs, and who is now devoting his whole time without remuneration to the investigation of the proper forms of ships of war, states that if, at an earlier time, a laboratory had existed, and proper experiments had been made, enormous sums would have been saved which have been expended in the actual construction of ships, or, as he terms it, in "experiments on the scale of twelve inches to a foot;" and that definite results would have been arrived at with less loss of time.

It will be seen from the evidence of General Strachey that he also disapproves of the mode in which Government is at present advised on questions of science, especially on the ground of the absence of scientific training in the political and official classes of this country.

Sir Wm. Thomson has given the following evidence:—

". . . With a vast amount of mechanical work which is necessarily undertaken by the Government, and which is continually in hand, questions involving scientific difficulties of a novel character frequently occur; questions requiring accurate knowledge of scientific truth hitherto undeveloped are occurring every day. In both respects the Government is at present insufficiently advised, and the result is undoubtedly that mechanical works are sometimes not done as well as they might be done, that great mistakes are sometimes made; and again, a very serious and perhaps even a more serious evil of the present system, in which there is not sufficient scientific advice for the Government, is the undertaking of works which ought never to be undertaken."

"Are you able to point out any instances which you have in your mind of mistakes which you think have occurred from the want of good advice on the part of the Government?—One great mistake undoubtedly was the construction of the *Captain*, and I believe that a permanent scientific council advising the Government would have made it impossible to commit such a mistake. They would, in the very beginning, have relieved the Government from all that pressure of ignorant public opinion which the Government could not possibly, in the present state of things, withstand."

The present system of Special Committees is objected to by Sir William Thomson, and by other competent witnesses.

Sir William Thomson thinks "that a single body would be better than a number of small committees for advising the Government on the great variety of questions which from time to time would be likely to arise."

Admiral Richards, late hydrographer of the Admiralty, is of opinion that—

"The members of such committees must be selected more or less to fulfil certain political conditions, and that, as a rule, they would come new to the subject that they were going to consider, and I do not believe that the Commission which sat on the Naval Designs the other day was a very successful one. I do not know that any great advantages have arisen or are likely to arise from it."

Mr. Froude, in reply to the remark, "You do not consider committees of that kind to be a very satisfactory way of proceeding?" thus states his objection to the present system:—

"I do not think so, because they have to find out the dream and the interpretation both, which is always a difficulty. They have to feel their way to a *locus standi*, which would already be possessed by a Council habitually operating with reference to the subject."

Additional examples of these defects are given, not only by these witnesses, but also by others, whom we shall quote when dealing with the proposed remedies.

Evidence was taken by the Commission as to the insufficiency of the present appliances for investigation. The attention of the Commission was especially directed to the want of laboratories for the use of the officials charged with scientific investigations urgently required for the economical management of the public departments.

Mr. Anderson, the superintendent of machinery at Woolwich, who has been responsible for the expenditure of "very nearly 3,000,000*l*. of public money," points out that there are no means at the disposal of State servants to enable them to investigate questions on which large expenditure depends. With special regard to his own department he states:—

"There is a very great deal which I should like to see taken in hand systematically. . . . . There is much that we are in the dark about; we are groping in the dark in almost everything at present."

". . . . Although we know a very great deal with regard to iron, cast, wrought, and in the condition of steel, there is yet very much which we do not know, and I am persuaded that if we could with certainty treat ordinary cast iron in the way that we sometimes do, nearly by chance, we would do away with three-fourths, or a very large proportion of the wrought iron which is now used in this country, and we should use cast iron."

He next refers to another question of great importance to almost all the public departments:—

". . . There is another very important subject which I might mention to the Commission. Some twenty years ago we were using ten or twelve pounds of coal per horse-power per hour, and the majority of engines still require six pounds, but by the improvements that have taken place we are now down to two pounds. There is a little engine at work now in the London district which is working at $1\frac{3}{4}$ pounds. There is a great gulf yet between getting steam-engines that will work at $1\frac{3}{4}$ pounds per horse-power per hour, and the point where we are now; I mean getting that done practically: but I believe that if the right man, or two men, were told off to thoroughly investigate this subject, and not to stop working until they had brought it to a practical shape, we could in ten years from this time get down to one pound per horse-power per hour. I see that there are very many leakages or loss in steam-engines in the very best way that we make them at present. The knowledge that was gained by Joule's experiments a few years ago seems to me to have been of immense value. Those experiments that he carried out for himself were the sort of thing which I think the Government should have done for the sake of the country. He did more to make engineers thoroughly dissatisfied with their present knowledge with regard to what they can do with steam than anything which had been done before. I believe that what Mr. Joule did will do more for this country than even what James Watt did. The part that James Watt took was very great, and the world gives him full credit for it, but the world is scarcely willing to give credit to Joule for what he will do; but he has made all engineers dissatisfied. They know that the best steam-engine is not doing one-sixth of the work which it ought to do and can do. That is a sad state of matters to be in when we know that we are so far wrong, but yet no one will go to the trouble of going to the end of the question so as to improve the steam-engine as it might be done; in fact, it will cost a great deal of trouble and a great deal of expense, I have no doubt."

With regard to the question whether it is "desirable that the Government should establish any laboratories for carrying on those investigations," he thus stated his opinion:—

"I should like to see a grand laboratory fitted with everything that would go towards the investigation of such matters, and at the same time a testing apparatus for getting at the physical facts as well. To get up the proper plant would be very expensive, but still I should like the nation to have it, so that any public department could go to this same laboratory and ask them for assistance to investigate any doubtful point."

Mr. Anderson's evidence finds a parallel in that given by Mr. E. J. Reed, M.P., late Chief Constructor of the Navy. He says:—

"I think that there are many branches of science remaining undeveloped at present, the development of which would be of great advantage to the country. I base that opinion partly upon the experience which I acquired at the Admiralty, in which I continually found that great and important questions were undeveloped for the want of organisation and of the means of developing them."

". . . A second illustration which I should like to give is this: the present condition of the marine steam-engine and boiler is very unsatisfactory. It is unsatisfactory to such an extent that I believe if the manufacture of iron and steel were improved with reference to its use in the construction of engines and boilers, and if improved material were applied by improved methods, a saving of one-half of the present weight would be attained; and when I say one-half, I know that I am speaking greatly within the limits which some persons who have thought very much about this question would be prepared to express. Of course, if that be so, if we are carrying about in our mercantile and other steamships twice the weight which is essential for the production of the power, that is so much taken off either from the further power and speed which might be obtained, or from the freightage and commercial value of the vessel.

"I may mention that in the manufacture of shafts, for instance, of the marine engine and of stern posts, and other large forgings for ships, the method of production is comparatively rude, and it very much needs development. . . . So much has the subject been neglected, that at this moment I have the responsibility of seeing some very large forgings indeed made for certain ships, and the most effectual manner in which I can give effect to my responsibility is that of selecting the very best working smith that I can find, and putting him into the manufactory where those things are being made, for him to do the best that his experience enables him to do, in order to see them properly constructed. I believe that if a regular independent scientific investigation were applied to a manufacture of that nature, enormous advantage would at once result."

The Standards Department of the Board of Trade is another department requiring advice in varied scientific subjects. The Warden of the Standards (Mr. Chisholm) states that there is no scientific authority to which he is entitled to appeal.

Sir William Thomson, in reference to the subject of standards, says:

"The conservancy of weights and measures is a subject involving questions of the most extreme scientific nicety. Faraday made statements showing how completely unknown at present are the properties of matter upon which we depend for a permanent standard of length. One of the very first objects that should be undertaken in connection with the conservancy of the standards of weight and length is secular experiments, on the dimensions of metals and solids of other classes under various conditions of stress, temperature, and atmosphere. Those would involve scientific experiments of an extremely difficult character, and also operations extending from year to year. There ought to be just now a set of experimental specimens of solids laid up which should be examined every year, or every ten years, or every fifty years, or every hundred years, the times when observations are to be made from age to age being regulated by the experience of the previous observations. This would not be a very difficult or expensive thing to institute in such a way as eventually to obtain good results, but it would be an operation of a secular character, which could only be carried out by the Government."

Dr. Frankland thus refers to the various requirements of Government involving chemical investigations:—

". . . The State requires many important investigations to be carried on. Such investigations are being continually conducted in buildings often very ill-adapted for the purpose, and which are fitted up for the purpose at a great cost. The laboratory of the Rivers Commission, for instance, which we have occupied for four years, was constructed in a house in Victoria Street; a rent of 200*l*. a year is paid for it, and it is literally nothing more than a moderate sized room, and two smaller ones, very ill-adapted for the purpose. Consequently, this laboratory is not so efficient as a building erected for the express purpose of conducting such investigations would be."

We pass now to

II.—*The Assistance given by the State towards the Promotion of Scientific Research.*

It may be convenient to consider the assistance given by the State towards scientific research as being either permanent or occasional.

Our museums of natural history are examples of the first. These afford to the students of those branches of science aid analogous to that afforded to students of literature and art by our national libraries and galleries.

No similar facilities are provided for the student of the physical sciences—such collections of instruments as exist being wholly inadequate both as to character and completeness. Moreover, as the Commissioners remark, "a mere collection of instruments, however complete, without working laboratories, is of little use to the student of the experimental sciences, and as there are no public laboratories available for the researches of private investigators, it may be said that in many branches of experimental science the State affords no permanent material aid to such investigators."

Assistance of a permanent description is also afforded to learned societies, by providing them with apartments free of rent, or with annual grants of money in lieu of such accommodation: the sum of 500*l.* granted annually to the Royal Geographical Society under certain conditions is an instance of such a grant.

We may regard as a permanent aid to science the grant of 1,000*l.* for researches carried on by private individuals, which is annually voted by Parliament, and administered by a Committee of the Royal Society.

The first proposal for such a grant was contained in a letter (dated October 24th, 1849) from Earl Russell then (Lord John Russell) to the then President of the Royal Society (the Earl of Rosse), and was to the following effect:—

> "As there are from time to time scientific discoveries and researches which cost money and assistance the students of science can often but ill afford, I am induced to consult your lordship, as President of the Royal Society, on the following suggestion:—
>
> "I propose that at the close of the year the President and Council should point out to the First Lord of the Treasury a limited number of persons to whom the grant of a reward, or of a sum to defray the cost of experiments, might be of essential service. The whole sum which I could recommend the Crown to grant in the present year is 1,000*l.*, nor can I be certain that my successor would follow the same course; but I should wish to learn whether, in your lordship's opinion and that of your colleagues, the cause of science would be promoted by such grants."

Lord Rosse, in reply to the proposal made by Lord J. Russell, expressed his personal opinion that the judicious employment of grants in the way proposed "would very materially promote the advancement of science;" and of the two alternatives, namely, expending the 1,000*l.* in rewards, or appropriating it to the payment of the expenses of experiments, he preferred the latter, indicating his reasons as follows:—

> "There are often details to be worked out before it is possible to employ usefully newly discovered principles. In many of the sciences reductions are required before observations can be made use of. Both in science and art, facts technically called constants are the materials of discovery; to determine them accurately is of great importance. Now in all these cases, and in many others, the work to be done is laborious and expensive, and as it adds but little comparatively to the fame of the individual, it especially requires encouragement."

With regard to this "Government grant" Sir Edward Sabine in his evidence says: . . . "I suppose that the 1,000*l.* in one year was designed as an experiment to try the matter in the first instance. I always understood that Lord Russell contemplated that the sum would be augmented if the plan were found to work well."

No change however has been made either in the amount of the grant or in its mode of distribution since its first establishment.

As examples of the second—occasional—kind of aid, expeditions for special researches, outfits of ships, and apparatus and grants of money for such researches, are mentioned. Great as is the value of these contributions, the Commissioners pointedly remark that "they do not appear to be granted or refused on any sufficiently well-defined principle."

The lesson, indeed, which crops up throughout the invaluable investigations of this Commission, is that there is a total want of system in almost all that we do, as a nation, towards advancing scientific research.

(*To be continued.*)

THE ENCYCLOPÆDIA BRITANNICA

The Encyclopædia Britannica; a Dictionary of Arts, Sciences, and General Literature. Ninth Edition. Vol. II., ANA to ATH. (Edinburgh: Adam and Charles Black, 1875.)

IN reviewing the first volume of this new edition of the "Encyclopædia" (NATURE, vol. xi. p. 343), we were obliged, by want of space, to omit more than the briefest possible remarks upon the general plan of the work. The conspicuous and increasing success of the work is apparently a sufficient answer to those who would find fault with the form of arrangement peculiar to this "Encyclopædia." Among the considerable number of Cyclopædias which have been produced in Great Britain during the last hundred years, this one, almost alone, has been reproduced in a number of successive editions, growing in excellence and reputation, and many people might take this fact to be a sufficient proof that it is well designed to meet a general want. But this success must surely be due in great degree to the eminence of the contributors, to the skill of the editors, or to any circumstance rather than the scheme of the work.

We have always been unable to comprehend the exact *raison d'être* of a cyclopædia which is neither strictly alphabetical nor strictly systematic. The "Britannica" may be compared to a solid body of pudding with plums in the form of excellent treatises disposed here and there. Now we entirely fail to perceive any convenience in this mode of construction. That it is not very suitable for the purpose of simple reference seems to be proved by the need of a full index to the whole of the volumes. Nor, if a person wishes to use one of the articles for careful continuous study in the manner of a text-book, is it convenient to have it embedded in a very heavy quarto volume, one of a large and costly series. Many valuable and highly useful treatises are in fact buried in this "Encyclopædia," and are hardly available for purposes of general reading. That this is so has been confessed by the separate publication of some of the principal treatises in former editions; those, for instance, by Sir John Herschel on "Physical Geography," and on "Meteorology."

Cyclopædias have varied in form from the purely alphabetical ones, best represented now in "Chambers' Cyclopædia," which approximates to the character of a dictionary, to "Lardner's Cyclopædia," in which each subject was treated in a distinct and handy volume. Coleridge tried to combine the two principles in the "Encyclopædia Metropolitana," in which all sciences and branches of knowledge were to be expounded in a series of elaborate treatises, arranged according to logical method, while an alphabetical dictionary of reference was added as a complement. The treatises contributed to this work by Herschel, Airy, De Morgan, Peacock, Whately, Senior, and others, are some of the most profound works in English scientific literature, and maintain their scientific value after the lapse of forty years or more. It was the weight of these too-valuable treatises which damned the commercial success of the whole scheme.

The "Encyclopædia Britannica" has effected a compromise between the systematic and alphabetic methods in another way, altogether inferior in a logical point of view, but far more successful as actually carried into effect. In this volume we have forty-four important articles, almost every one of which is written by a master of the subject, if not in every case by its most eminent representative. The longest of these except one is that on *Astronomy*, by Mr. R. A. Proctor. It occupies eighty quarto pages, in addition to four large plates of engravings, and might be easily made to fill a good-sized octavo volume of 400 or 500 pages. This article is on the whole a satisfactory compendium of the science, but it is matter of regret that Mr. Proctor cannot avoid exhibitions of bad taste. He has no right to insinuate in the second column of p. 786 that two of the joint authors of an important scientific paper are the *assistants* of the one first named. The accuracy of some of Mr. Proctor's statements as to the history of recent discoveries in solar astronomy would have to be seriously called in question, were it possible in an article of this kind to enter upon a subject involving many details.

One of the most profound and at the same time interesting articles is that of Dr. E. B. Tylor on *Anthropology*, occupying about sixteen pages. As we should expect from the principal founder of the new science, it contains a luminous abstract of the evidence concerning the antiquity, descent, and development of the human race, mainly brought to notice since the last edition of the "Encyclopædia" was published. Taken in connection with Prof. Daniel Wilson's article on *Prehistoric Archæology*, and Prof. St. George Mivart's elaborate account of the *Ape Family*, filling twenty-one pages, we have in this single volume of the work a full supply of information relating to the origin and affinities of the human species. It is curious to compare the views discussed in these articles with those propounded in earlier editions of the "Encyclopædia" under the title "Creation."

Probably the longest article in the volume is that, the joint production of Prof. T. Hayter Lewis and Mr. G. E. Street, upon *Architecture*, which, taken together with a very useful glossary of architectural terms, extends over ninety-four pages. If reprinted in a separate volume it would form a convenient and much-needed text-book of the science. As treated by Mr. Ferguson, the history of architecture forms in fact one of the most instructive branches of the new science of Sociology, and no subject of study is better calculated to produce correct views of the origin and development of civilisation. We are unable to understand why the work of Mr. Ferguson is referred to in the Bibliography of the subject (p. 457) only under the head of Chinese Architecture.

It will be a matter of regret to many that Professor Huxley's article on the *Classification of the Animal Kingdom* is restricted to six pages, but it is surprising how many profound remarks he has managed to compress into this narrow compass. The article, however, is only suited for the reading of experts. The article, again, on the word *Aryan*, by Prof. Max. Müller, is another one of which the brevity must be lamented, unless it be supplemented by other articles on closely allied topics, to which there is no reference.

In spite of the fulness and excellent quality of some of the articles relating to physical or natural science, we entertain some fear that the weakest side of the "Encyclopædia" will lie in this direction. The method of arrangement prevents us from speaking with confidence, because it is impossible to say how far subjects which are weakly treated or altogether omitted in their alphabetical place, will be introduced into later systematic articles. There are indications, however, that Prof. Spencer Baynes is not as ably supported in chemical, mathematical, or general physical subjects as he should be. The brief account of *Antimony*, for instance, is a very perfunctory production, and, if the other elements are to be treated in like manner, we should prefer to find them omitted altogether. If Mr. Baynes can spare barely more than one column for an element of considerable importance, he need not have told us that the paint said in the Holy Scriptures to have been used by Jezebel was made of stibnite containing antimony. Nor need a sentence have been wasted in repeating a tradition to the effect that the metal was called antimony because a preparation of it proved fatal to monks (hence *antimonachos*), a tradition, it is added, which will hardly bear investigation. If so, why give the tradition when there is so much else of importance omitted.

The article on *Assaying*, though not positively bad, is not up to the proper mark, and is not sufficiently precise to be of any technical value. The subject should either have been omitted or more developed, and placed in the hands of Mr. Chandler Roberts, the chemist and assayer of the Royal Mint, who would have been in every way the most fit writer to treat it.

We hope that the column given to *Anthracite* is not a specimen of the way in which so important a subject as Coal is to be dismissed. Yet it contains no reference to Coal, Fuel, or other articles on related topics. Moreover, we are unable to comprehend why, if there is to be a satisfactory systematic article on Coal, as surely there must be, this brief separate account of anthracite should be given. As the article remarks, "No sharply defined line of demarcation can be drawn between anthracite and the bituminous varieties of coal, as the one series merges by imperceptible degrees into the other." If so, why allow the mere name to give rise to a separate article, when the alphabetic system is not observed in other cases?

Every now and then the mixture of systems gives rise to a waste of space by useless repetitions. Thus, under *Asteroids*, we find an article of seventeen lines, ending with a reference to p. 806 in the article on *Astronomy*. Turning to this page, we find a pretty full account of the asteroids, filling four columns, and containing a complete and useful table of the whole of the minor planets, which were 143 in number when the table was drawn up, although two or three new additions have since been made. It is obvious that a mere reference under the name *Asteroid* would have been sufficient. The editor avoids the introduction of the copious references which are to be found in the "Penny Cyclopædia," "Rees' Cyclopædia," and many other ones, but he does not do this consistently and completely. In other cases subjects of considerable importance are treated with the brevity of a dictionary, and yet no references are added. Take, for instance, the account of the word *Anodyne* given in seven lines, and containing merely the meaning and etymology of the name, and a list of six substances used as anodynes. There is no reference to anæsthetics or any other article where the subject might be fully studied.

Perhaps the worst article allowed to stand in this volume is that under the word *Angle*, which tells us in twenty-seven lines, and by aid of a figure, what an angle is, what a right angle is, how the whole circumference is divided into 360°, and so on, concluding by a reference to geometry and trigonometry. Such a puerile description of the word would not be tolerated in "Chambers' Information for the People" or Cassell's Popular Educational works. There is only a single sentence in this article which could in all probability give new information to any person likely to consult such a work as the "Encyclopædia Britannica."

It is not our duty, of course, to form any judgment upon the larger part of this volume, which treats of literary or artistic subjects. The many articles treating of classical, biographical, geographical, and other information are probably on the whole superior to the parts devoted to physical and mathematical science. The scarcest and perhaps the weakest articles altogether are those on mathematical topics. There are, indeed, in this volume only two articles of any length which can be called mathematical. That on *Annuities* is a fair one, especially as supplemented by other articles to which reference is made. That upon *Arithmetic*, however, is a very dry, perfunctory production, chiefly consisting of a mere compendium of the ordinary rules. We do not recognise the name of the author by his initials, and the name is not made public in the list of principal contributors. It is obvious that the "Encyclopædia Britannica" will not compare in the mathematical department with the "Penny" or the "English" Cyclopædias, which contain a splendid series of articles by De Morgan of permanent interest and value. While, therefore, we can entertain no doubt that, taken as a whole, the "Encyclopædia Britannica," as now republishing, is excellently edited, we think that Prof. Baynes is inclined to sacrifice in some degree the less for the more popular branches of knowledge.

We are driven to this conclusion when we compare the number and length of the articles given to the more severe scientific subjects with those upon more popular topics, such as *Architecture* and *Archæology*. The treatise on *Army*, again, taken in connection with that upon *Arms and Armour*, takes up a very large amount of space. No doubt it is requisite that War, which occupies unfortunately so large a part of the attention of Europe at the present time, should be fairly noticed in an "Encyclopædia" intended for the use of all. It is a matter of opinion and a question of degree and of proportion in which it is hopeless for Prof. Baynes to please all parties. But it may be well to remind Prof. Baynes that the more popular articles are those which will soon lose their value. Such an article as that on *Army* rapidly becomes antiquated by the progress of political and social changes and of mechanical invention, whereas good mathematical essays like those of De Morgan or Peacock retain their value for hundreds of years. Almost the only volume of "Lardner's Cyclopædia" now sought after is that by De Morgan on the Doctrine of Probabilities.

Although the "Encyclopædia Britannica" seems a very costly work to purchase, it must really be considered, in proportion to its contents, very cheap. We find that this second volume contains at least 1,100,000 words, in addition to thirty large and expensive engraved plates. Now, the same quantity of matter purchased in the form of detached treatises would probably cost from two to four times as much. It is true that when we select our own library we generally purchase works which we intend to read more or less completely, whereas the persons who would read an encyclopædia through would be truly exceptional characters, though we have heard it reported that such persons do exist. A cyclopædia is published on the principle which auctioneers seem to adopt in selling books, of mixing up what a purchaser does not want with what he does want; so that he has to buy all the more. Those, however who do want a library selected for them cannot do better than confide in the work of Prof. Baynes and his predecessors.

OUR BOOK SHELF

Annual Record of Science and Industry for 1874. Edited by S. F. Baird. (New York: Harper and Brothers, 1875.)

The Year-book of Facts in Science and the Arts for 1874. Edited by C. W. Vincent, Assistant in the Library of the Royal Institution of Great Britain. (London: Ward, Lock, and Tyler, 1875.)

THE American "Annual Record of Science," is a work that each year grows in interest and value. It now consists of two distinctive parts (1), an historical summary of the progress of various branches of science and industry during the past year; and (2), classified groups of paragraphs, giving a succinct report of noteworthy occurrences or special scientific investigations. At the end of the volume is a catalogue of scientific books published during the year, and also a capital index to the whole work. The summary of progress has grown from sixteen pages in 1871, when this Annual first appeared, to 200 pages in the present volume. Each department of science is separately treated, and in the preparation of the different parts the editor has had the co-operation of numerous eminent men of science. Evidently no pains have been spared to make the Record as complete as possible, and so far as we are competent to judge, it is as accurate as it is comprehensive.

In his modest preface to the volume, the editor tells us he has been urged by some to make the abstract of papers more detailed; we think, however, Mr. Baird has exercised a wise discretion in his present arrangement, and at the same time we are glad to learn that he intends publishing a series of annual reports on special branches of science similar to what already exists, to some extent, in Germany. In England we have nothing corresponding either to the general record of science or to the special reports, and the want of such works is increasingly felt. We hope that before long some one of our leading publishers will see their way to issuing a really good digest of the annual progress of natural knowledge in all its various branches.

Why could not the record before us be published in England as well as in America? This seems a very feasible plan, and would doubtless add to the usefulness of the work, inasmuch as English collaborateurs might be added.

Very different from the American annual is the English year-book, yet it is, we believe, the only "year-book of science" of which we can boast. Outside it resembles a shilling railway novel; inside it is a pleasant gossipping account of odds and ends of science picked up at the Royal Institution. An altogether disproportionate amount of space is devoted to extracts from the papers and addresses of Prof. Tyndall, and the woodcuts on the title-page are taken from the same source. We are glad, however, that the "Year-book of Facts" still remains, notwithstanding the death of its former indefatigable compiler. Mr. Vincent tells us he undertook at short notice to continue the work of the late Mr. Timbs. To compile a year-book under such circumstances can be no light duty, and hence we must be lenient to its shortcomings. So far as the book goes, Mr. Vincent has done his work well, and gives a bill of fare that no doubt will be relished by the *dilettante* scientific public. But it should be clearly understood that the volume is merely a *scrap-book* of popular science, and not in any sense an annual register, such as we hope may soon be issued.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Systems of Consanguinity

IN Sir John Lubbock's *vindication* of his original charge that I seem to have two theories of the facts in my work on Consanguinity (NATURE, vol. xii. p. 124), he fails to show that the classificatory system was interpreted by me as "arbitrary, artificial, and intentional." This is one of the theories, and in fact the principal one, which he ascribes to me, and which I repudiate. The other theory, that which I did advocate, is presented both in his address before the Anthropological Institute and in this vindication (stated partially and imperfectly), as something that I "admit." "Mr. Morgan admits that systems of relationship have undergone a gradual development, following that of the social system." (Address, p. 4, NATURE, vol. xii. p. 125.)

It would require too free a use of your columns to explain at length how, by quotations severed from their connections, and by a use of their phraseology not in accordance with my design, a defence of an unwarranted statement has been put together.

I beg leave to re-state the propositions in my work on Consanguinity, which contain the substance of the views I have advocated, and to which I stand committed; and to request those who may be interested in the subject to read the last chapter in the light of these statements.

In that chapter, entitled "General Results," the facts are discussed under seven propositions, in substance the following:—

Proposition I. That the systems of consanguinity given in the tables may be resolved into two, which are radically distinct, one of which is called *descriptive* and the other *classificatory*. The first is that of the Aryan, Semitic and Uralian families, and the second that of the Malayan, Turanian, and Ganowánian families.

Proposition II. That these systems are to be ranked as domestic institutions.

Proposition III. (in full). "Can the origin of the descriptive system be accounted for and explained, from the nature of descents and upon the principle of natural suggestion, on the assumption of the antecedent existence of marriage between single pairs?" (Con. p. 472.)

The affirmative of this proposition is maintained. "It is the institution of marriage between single pairs which teaches the descriptive system; whilst this form of marriage has been taught by nature through the slow growth of the experience of the ages." (Con. p. 469.)

Proposition IV. (in full). "Can the origin of the classificatory system be accounted for and explained, from the nature of descents, upon the assumption of the existence of a series of customs and institutions antecedent to a state of marriage between single pairs, of which the Hawaiian custom is one?" (Ib. p. 474.)

The affirmative of this proposition is likewise maintained. Under it the solution of the origin of the Malayan system is given, and also of the Turanian, together with the customs and institutions, fifteen in number, arranged in a sequence, which stand connected with the birth and growth of these systems. Assuming, for example, the intermarriage of brothers and sisters in a group, every relationship in the Malayan system is found to be that which would actually exist; wherefore, the system itself proves the antecedent existence of this form of marriage. The same line of argument and of inference is then applied to the Turanian system. In Propositions III. and IV. I speak of both forms as *natural* in contradistinction to *artificial*, although they are radically different. They are natural in the sense that they are in accordance with descents as they actually existed when each system respectively was formed. This is the main proposition in that chapter, occupying in its discussion nineteen of its forty-three pages. It presents the theory of the author; it is the only place where the origin of the classificatory system is discussed.

Proposition V. This proposition maintains the unity of origin of such tribes of the American aborigines as are found to possess an identical system of consanguinity.

Proposition VI. (in full). "Where two or more families, constituted independently on the basis of such a system of relationship, are found in disconnected areas or upon different continents, can their genealogical connection be legitimately inferred from their joint possession of the same system?" (Ib. p. 498.)

After showing that the people of South India who speak the Tamil, Telugu, and Canarese dialects have a system of consanguinity identical with that of the Seneca-Iroquois of New York, in upwards of 200 relationships, the question is raised, "How shall this identity be explained?" It was my discussion of this question that confounded my distinguished adversary, which he misunderstood at first, and is not sure that he "quite comprehends even now." How his difficulty could have arisen I confess puzzles me. Under Proposition III. the origin of the descriptive system had been discussed, and under Proposition IV. that of the classificatory; but under this (VI.) the question was whether any evidence of the Asiatic origin of the Ganowánian family could be found in this identity of systems. The four hypotheses quoted by him (vol. xii. p. 124) are produced and discussed here. "Spontaneous growth" was referred to and of course rejected as an adequate explanation of this identity of systems.

Proposition VII. relates to inferences that may be drawn from partial identity of systems.

These several propositions show very plainly, I submit, that these systems are not explained in that volume as "arbitrary, artificial, and intentional," and equally plainly that they are explained as growths or results of certain customs and institutions.

Turning now to Sir John Lubbock's vindication, his first principal quotation is taken from the discussion of my first proposition, where "natural and spontaneous" is used in opposition to resulting growths from customs and institutions, the cause being unknown in the first case, and known in the second. His second quotation is from the discussion of my sixth proposition, where "spontaneous growth" is used, and in the same sense.

The discussion of the mass of materials accumulated in that volume was confined to forty-three out of five hundred and eighty-three pages. It was a new subject, in which it was necessary to invent, to some extent, a new terminology. I am aware of its great defects, but I deny that two theories of the facts are to be found therein, or that I have explained the classificatory system as "arbitrary, artificial, and intentional," which is the point from which this discussion started.

Rochester, New York, July 20 LEWIS H. MORGAN

Weather on the Atlantic

I HAVE reluctantly come to the conclusion that attempts to forecast the weather on the North Atlantic frequently result in disappointment. A recent passage from New York to this country has enabled me to gather some remarkable data on this subject, so remarkable, indeed, that any one crossing for the first time might reasonably question the action of the barometer. If I had had only one on board, I should certainly have doubted its accuracy, but having three, the readings of them cannot be questioned by the most sceptical.

We left Sandy Hook on the forenoon of April 10, with a light north-west wind and pleasant weather. Temperature of the air 46, barometer 29·82. From that date to the 16th the ship steamed 2,210 miles, and the mercury, with the exception of a slight fluctuation which never exceeded $\frac{8}{100}$ of an inch, fell steadily until it reached 29·14 on the latter day. Throughout this period the wind veered and backed between N.N.W. and E.N.E., never exceeding in force a whole sail breeze, and frequently light or calm for hours together. The sky was generally overcast until the meridian of 32° W. was passed; light rain fell once, but no snow or sleet. Temperature of the air ranging between 34° and 57°.

Until the ship was to the eastward of Cape Race (passing 300 miles south of it), as no gale blew I expected a heavy fall of snow; but as it did not come, I assumed that the snow-covered ice on the Grand Bank of Newfoundland caused this unusual depression of the mercury. Great was my surprise, therefore, to see it falling lower as the distance increased from the supposed cause of the depression, while the wind gradually died away, the clouds opened out and assumed softer forms, the horizon cleared, and the long northerly swell subsided. The latter is always a sign of fair weather on this troubled sea. If a storm be advancing towards a ship, the swell usually comes before the wind, so quickly is the motion of the water translated.

While on the subject of waves, I may state that I have been investigating the cause of the greater height of the waves raised by a north-west wind above those raised by a south wind. The observations were made while crossing several offshoots of the Gulf Stream, and I found that in every instance the sea was smoother in the warm water than in the cold. If this view be correct, then the waves in tropical seas should be inferior in height to those of the temperate zone. The question is, Are they so?

Snow has an extraordinary effect on the barometer, but its action is most mysterious, as in this case the ship was several hundred miles from any locality where snow could have fallen.

In March 1872 I witnessed a similar instance of great depression in the barometer, with no wind and a clear sky. On reaching the land it was found to be covered with snow. In that instance there was scarcely a cloud visible during the last 400 miles, and not a single flake fell on the ship. I believe the remarks of an old seaman on the weather of the Atlantic are very true, viz., "The longer one sails on it the less one knows about it."

The presence of heavy field-ice in the month of April, so far south as 41° 40′ N., only fifty miles north of the latitude of Naples, has excited considerable astonishment amongst Atlantic navigators, since many steamers were entangled in it as early as the 24th of January.

The Admiralty Chart of 1873 indicates March as the first month of its arrival, and further gives lat. 42° 13′ N. as the extreme southern limit of its existence, whereas it has already been met with twenty-seven miles south of that parallel, forming a dangerous barrier to ships on the great highway to America: and the commanders of those vessels, relying implicitly on the correctness of a survey which should be above suspicion, have seriously injured their vessels, thereby jeopardising many lives and valuable property in a locality where every feature of it should be as well known as the waters of the Serpentine or the Thames above bridge. It is, moreover, notorious that this is not the only defect in the chart of 1873. The northern limit of the Gulf Stream is laid down from 100 to 150 miles south of its true position; and the existence of another important current (the Labrador), which plays no mean part in the economy of the globe, is entirely ignored, although its line of demarcation from the adjacent waters is as well defined as that of its great neighbour.

It is stated by the old residents of Canada that such a severe winter as this has not occurred in the Dominion for forty years. During the months of January and February at Montreal the wind only blew from the south for six hours. Not only was the thermometer low, but the northerly gales were incessant, rendering outdoor exercise almost an impossibility. These storms broke the ice of Newfoundland and Labrador from its moorings before the summer sun could soften it, and hence the reason of its floating down south. Being almost as hard as granite, and with the sea water at 30°, it will not readily decompose.

The recent severe winter must affect the fortunes of the polar expedition for good or for evil. Channels into which ice has drifted will become inaccessible until late in the season, but, on the other hand, the pack-ice will be less inconvenient from its solidity and compactness. It is not probable that many large bergs will reach the Atlantic this season.

Celtic W. W. KIDDLE, R.N.

The late W. J. Henwood, F.R.S.

MR. G. T. BETTANY is no doubt very nearly, if not quite, correct in saying of Mr. Henwood (NATURE, vol. xii. p. 293), "I believe that scarcely one of his cherished objects in this respect [the arrangement of his stores of facts and observations] remains unfulfilled."

In a letter to me, dated July 31, 1875, Mr. Henwood remarked: "I believe all I have done since [I wrote you last] has been to make some preliminary calculations regarding the corrections for temperature of the results of my observations on magnetic intensity, made on the surface and near the bottom of Dolcoath Mine in 1832. I think they hold out promise of something if I have only strength to put them in order." On the fifth day after writing this he died. M. Y.

Zoology of the "Erebus" and "Terror"

Palmam qui meruit ferat. Referring to the article on this subject (NATURE, vol. xii. p. 289), allow us, as the publishers of the botanical portion, to say that the indefatigable labours of Dr. Hooker, aided by the Government grant, resulted in *six* vols. 4to.; not *two*, as stated by the reviewer. This was published in three divisions, viz.: 1. Flora Antarctica, 2 vols.; 2. Flora Novæ Zealandæ, 2 vols.; 3. Flora Tasmaniæ, 2 vols.; the whole comprising nearly 600 coloured plates.

L. REEVE AND CO.

5, Henrietta Street, Covent Garden, Aug. 14

The Rocks at Ilfracombe

COULD any of your readers state in your columns the nature of a curious appearance in the rock near Ilfracombe (North Devon), on the way to Coombe Martin, just where the road begins to descend to the latter place? Here on the right-hand side the bank is considerably excavated, and through the scaly and friable strata, whose cut surface is perpendicular to the road, rock of a harder kind seems to have been pushed, presenting a rounded surface, which gives the appearance of trees laid in the bank and partly uncovered; indeed, I first heard of them as "petrified trees," and from the road they look very much like the trunks of silver birches. Our Ilfracombe driver told me that a great many people came to look at them, some saying they were trees, others that they were not.

There are several of them, and various lengths are visible, from about a yard to twenty feet, I should think.

WILLIAM S. TUKE

OUR ASTRONOMICAL COLUMN

BINARY STARS.—(1) η CASSIOPEÆ.—Dr. Duner, of the Observatory of Lund, Sweden, has calculated elements of this binary from measures 1782-1874; the orbit is as follows:—

Peri-astron passage,	1748·413	
Angle between the lines of nodes and apsides	245°·91	Meridian of 1850
Node	50 ·83	
Inclination . .	68 ·46	
Angle of excentricity ($= \sin^{-1} e$)	38 ·812	
Mean annual motion	+ 2 ·04112	
Semi-axis major	10″·681	
Period of revolution . . .	176·374 years.	

The comparison with measures used by Dr. Duner in his calculation shows very small residual errors, but the elements here transferred from Leverrier's "Bulletin International" of the 12th inst., though representing the angles of Struve, Dawes, Jacobs, and Dembowski, with small negative errors give the distances measured since 1827, very sensibly in defect of the observations. Thus for Dembowski's measures we have—

1863·26	Error in position	− 0°·72	Error in distance	− 0″·69
1867·16	,, ,,	− 0 ·71	,, ,,	− 0 ·63
1871·05	,, ,,	− 0 ·18	,, ,,	− 0 ·46

For a normal founded upon measures by Jacobs, Dawes, and Dembowski, for 1854·20, the error in position is, – 2°·4, and in distance, – 0″·74. The elements above are perhaps affected by error of copy, but as they stand they will admit of some improvement.

With Dr. Duner's semi-axis and period, and Mr. Otto Struve's first approximation to the annual parallax, the mass of this system would be upwards of ten times the solar mass.

It will be remarked that the angles in the above orbit are expressed by Dr. Duner in decimals of degrees, and we may take this opportunity of directing attention to a very useful table of five-figure logarithms adapted to decimals of the degree published at Berlin in 1872 by Dr. C. Bremiker, which will be found available not only in double-star computations, but very generally for five-figure work. The figures closely resemble those in De Morgan's well-known tables (which are now apparently out of print), and consequently are exceedingly clear and readable, and the price nominal (one shilling). Several miscellaneous tables and various useful constants are appended. The work will be sent over in paper cover, and in binding this or any other set of tables for frequent use, we would recommend the strong gilding of all the edges as materially facilitating their working. When shall we have a table of *four-figure* logarithms to the same extent as tables for five figures are usually printed? Such a work would be by no means without its value.

(2) γ LEONIS.—Dr. Doberck, of Col. Cooper's Observatory, Markree, has calculated elements for this star, though the arc described is at present less than 30°, under which condition orbits widely different may be obtained. Peri-astron passage, 1741·11; period of revolution, 402·6 years; node, 111° 50′; λ, 194° 22′; γ, 43° 49′; excentricity, 0·7390; semi-axis major, 2″·00.

There are several of the revolving double-stars of which much better orbits than have yet been published might now be found; as, for instance, ω Leonis and λ Ophiuchi. Of the fairly determined orbits, the shortest period appears to be that of 42 Comæ Beren—25·5 years, according to Mr. Otto Struve; and the longest that of Castor, 997 years, according to the very complete investigation of Herr Thiele.

THE MINOR PLANETS.—M. Leverrier, in his "Bulletin International" of the 8th inst., announces the discovery of No. 148 at Paris, by M. Prosper Henry, on the same morning. The planet is of 10·7 mag., and was found a little west of 70 Aquarii.—Circular No. 31 of the "Berliner Jahrbuch" contains new elements of Lachesis (120); the period of revolution at the next opposition in November is 2,028 days. In No. 30 appeared new, though still uncertain, elements of Austria (136); period 1,261 days.

THE AUGUST METEORS.—The extensive systematic plan of observation at the principal meteor epochs which has been for some time organised by the Scientific Association of France, at the instance of M. Leverrier, has again been attended with success, on the occasion of the Perseid shower. At Rouen on August 9, between 11h. and 15h., 200 meteors were noted, of which 180 came from the Perseus-radiant; at Rochefort, on the same night, 258 meteors were observed, nearly the whole conformable; and on the 11th, at the same place, 260, many with the same radiant.—About August 5th, in the neighbourhood of London, an unusual number of meteors, more than one as bright as stars of the first magnitude, diverged from Omicron in Andromeda.

Prof. Oppölzer's *definitive* elements of Comet 1862 (III.), with which the August meteor-stream is associated, are here subjoined:—

Perihelion passage, 1862, August 22·91192 G.M.T.

Longitude of perihelion ...	344° 41′ 32″	M. Eq. 1862·0
,, Ascending node ...	137 27 10	
Inclination to ecliptic ...	66 25 48	
Eccentricity	0·9607588	
Semi-axis major	24·53142	
Period of revolution	121·502 years.	

The point of nearest approach to the earth's orbit at the descending node is passed 19·357 days after perihelion; if in 1862 the comet had arrived at perihelion July 21·557, a little before noon on the 10th of August, it would have been distant from the earth less than twice the distance of the moon. It might not be without interest to determine the effect of so close an approach to our globe, upon the orbit of the comet; but in such an unusual computation it appears almost necessary that earth and moon should be treated as distinct disturbing agents; perhaps the ordinary methods might apply, if the intervals were taken sufficiently short and the elements changed with sufficient frequency.

THE SEPARATION OF THE ARAL AND THE CASPIAN

IN a note on the Hyrcanian Sea (vide NATURE, vol. xii., p. 51), it was stated that the waters of Aral, whose surface is now about 159 feet above sea level, formerly overflowed at their S.W. corner, when the lake possessed a depth of 50 feet more than at present. It is certain that the spur of Ust Urt, which formed a waste weir at the point in question, has been lowered by the action of escaping water; and the level at which the overflow took place, in the first instance, was probably some few feet higher than the figure of 209 which has been given. The greatest height ever reached by the water contained in the basin of Lake Aral may therefore be said with tolerable accuracy to be about 220 feet above the sea.

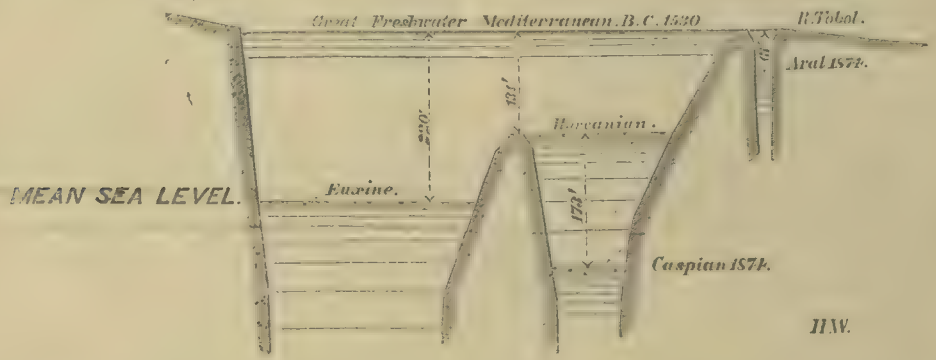
On the N.W., near the head of the Tchagan stream, where Aral must have overflowed to flood the country round the limits of Ust Urt, the barometrical height of a point situated in latitude 47° 7′ 27″, and longitude (east from Greenwich) 58° 17′ 41″, is 257 feet (a). This height approximates sufficiently to that which has been indicated for the overflow at S.W., to suggest that future levelling operations will find a point somewhere in this neighbourhood situated at less than 220 feet above the sea. There is, in addition, in latitude 43° 15′, a cleft in the eastern cliff of Ust Urt, by which, and probably by other similar clefts yet to be discovered, the waters of Lake Aral may have overflowed to the west; and in such a case they would, as they travelled down to the lower level of the Caspian Sea, have submerged many extensive, depressed tracts, which occur on the surface of the intervening country. The separation of the two seas, which has afforded subject for much discussion, seems thus actually to have been due to the cessation of the overflow of the basin upon the higher level. Nor is, perhaps, that separation so entirely complete as has generally been thought, for Lake Aral could possibly be filled and made to overflow again; and under such restored conditions, the physical aspects of the country lying between the two seas would very nearly resemble those which are possessed at the present time by the country on the lower courses of the Amú Darya, and are caused by the annual flooding from that river. In such a drowned condition, the Aralo-Caspian region was naturally included in the water-spread of the Hyrcanian Sea by all the classical historians and geographers who have described it; and though, perhaps, no possible overflow from Lake Aral could now exactly reproduce the physical aspects of 2,000 years ago, such difference as would be observable is susceptible of explanation by considerations to be presently entered upon.

Since the accidental circumstance of more or less water having existed in several depressions upon the surface of the Aralo-Caspian region is the only known variation which has attached to its physical aspects from the earliest historical times, there is a strong presumption that no phenomena of upheaval have occurred, and that overflow could still take place in a northerly direction also from Lake Aral. Some sixteenth century maps show the river Obi flowing out of the lake of Kitay, which is one of the names of Aral; and by such an overflow may be explained that supposed irruption of Ocean into Asia which the most ancient Greek and Latin authorities have recorded. Nor would the demonstration of the possibility of this overflow in any way affect the reputation either of Herodotus or of Aristotle, who both maintained the isolation of the Hyrcanian from the ocean; for the overflow from Aral might or might not have taken place during a series of years, depending as it did upon the magnitudes of the annual floods of the rivers which supplied it, at the epoch when the winter broke up, on the highlands of Central Asia.

(a) These figures are taken from the Catalogue of Trigonometrical and Astronomical points in the Russian Empire. Edited by the Director of the Geodesical Department of the Military Topographical Staff.

It was estimated in the note on the Hyrcanian Sea that when the Oxus discharged directly westwards, the waterspread of Lake Aral and the lands drowned by its overflow might have added about 70,000 square miles to the area of 140,000 square miles, which is possessed by the Caspian of to-day. If 30,000 square miles be added besides, for the volume which Oxus, Ochus, and Arius probably supplied, the total area of the Hyrcanian Sea would have been about 250,000 square miles, which would have formed a waterspread almost reaching up to the ridge which divides the Caspian from the Black Sea, *i.e.* the level of the largest possible Hyrcanian Sea may have been 89 feet above mean sea-level, in the lowest of the two basins which formed it. The observations of Pallas have, however, placed beyond doubt that the ancient limits of the Caspian were situated at a much higher level than this; and since these limits, which are delineated in a map illustrating his works, did not owe their existence to the overflow from Aral, in conjunction with the volumes of water delivered by the rivers of the Caspian basin, they must have been formed by water flowing out of the Euxine basin. And this latter could not consequently have had at such a time a communication with the Mediterranean Sea.

We know that at the present day a very much larger volume than is required to compensate its surface evaporation is contributed by the various rivers supplying the Black Sea, and passes thence through the Bosphorus into the Sea of Marmora. Before this escape existed, the level of the Euxine would have been higher, and the surplus waters would have overflowed to the east by the channel of the Manytsch into the basin of the Caspian, whose level would, in turn, have been raised. The united waterspread of the two basins would have continued to rise, until the surface evaporation equalled the supply of water it received; or until it found an escape into a lower level, and this latter circumstance was the one which almost certainly occurred, and in a northern direction.



The part of the ancient shore of the Caspian, which Pallas has delineated, and which is situated at a point called Cholon Komyr, in latitude 45° 30′ 25″, and longitude (east from Greenwich) 44° 51′ 34″, has a height of 221 feet above the sea (*b*). In other words, the great inland sea of fresh water, which extended from the western shores of the Black Sea to the eastern shore of Lake Aral, had its surface precisely on the level at which, it has been stated, there is a strong presumption that Lake Aral could overflow to the north and form a junction with the Frozen Ocean by the drainage lines of the Tobol and of the Obi. Under all the circumstances it is scarcely hazardous to say that this presumption becomes all but a certainty; and that the height of the low ridge, which divides the drainage on the north of Lake Aral, will eventually be found to be 220 feet or less, at its lowest point, above sea-level.

The actual original separation of the Aral and the Caspian may thus be referred to the rupture of the Bosphorus, and to that consequent rush of waters from the Euxine into the Mediterranean, which is known as the Deluge of Deucalion. The immediate result of this cataclysm would have been a fall in the level of the Caspian from 220 to 89 feet above the sea; and though actually isolated from Lake Aral, it would have appeared connected with it by marshes, alimented by the overflow of the latter basin. Though the Caspian level still continued to fall, from surface evaporation, the aqueous character of the intervening bed of the drained-off waters would thus have been preserved for a long time, and such a condition will explain the probable difference in physical aspect which would distinguish the long since desiccated Aralo-Caspian region if it were subjected once more to an overflow of Lake Aral. The cessation of this overflow would have, in the first instance, hastened the drying up of the higher levels of the intervening country, and accentuated to the Orientals upon the shores of the higher sea that isolation of the two basins which the Europeans upon those of the lower were not, and in fact could not be, acquainted with until very long afterwards.

HERBERT WOOD

(*b*) See note (*a*).

GUN-COTTON WATER-SHELLS

IN the published accounts of Field Artillery Experiments which are just now being carried on at Okehampton, in Devonshire, considerable prominence has been given to the formidable nature of the so-called water shells, with which practice has been carried on against rows of targets, in the form of "dummy" soldiers, representing columns of infantry, shrapnel shells and common shells, filled with gunpowder, having been fired in comparison with them.

The term *water-shell* denotes not a shell of special form or construction, but simply a new system of bursting shells of ordinary construction, elaborated by Prof. Abel nearly three years ago, by which the breaking up of cast iron shells into a large number of fragments and their dispersion with considerable violence is accomplished by filling the shell with water instead of with an explosive agent.

In a memoir communicated by Mr. Abel to the Royal Society in 1873,[*] it was pointed out that detonation was transmitted from a mass of dry compressed gun-cotton to distinct masses of the material saturated with water and separated from each other and from the detonating (or "initiative") charge by small spaces filled with water, the whole being enclosed in a case of stout wrought iron; and Mr. Abel stated that the suddenness and completeness with which detonation was transmitted through small water-spaces had suggested to him the possibility of applying water as a vehicle for the breaking up of cast iron shells into numerous and comparatively uniform fragments, through the agency of force suddenly developed in the perfectly closed shell, completely filled with water, by the detonation of a small quantity of gun-cotton or other similarly violent explosive substance, immersed in the water. Mr. Abel considered that if such a result were obtained, a shell or hollow projectile of the most simple construction could be made readily to fulfil the functions of the comparatively complicated *shrapnel* and *segment* shells which have been specially designed to furnish a large number of dangerous missiles when burst during their flight.

A few experiments with ordinary cast iron shells, spherical and cylindro-conoidal, afforded conclusive demonstration of the power possessed by water, in virtue of its slight compressibility, to bring to bear uniformly in all directions upon the walls of the shell, the force developed by an explosion which is made to occur suddenly in the completely confined water-space, and showed, moreover, that the disruptive effect was proportionate not merely to the amount of explosive agent used, but also to the suddenness of the concussion imparted to the completely confined water by the explosion. In illustration of the disruptive effect of water, the following results may be quoted from a number given by Mr. Abel in his memoir. A 16-pounder (cylindro-conoidal) shell, filled with 16 ounces of gunpowder, was broken by the explosion of this charge into 29 fragments. The detonation of a quarter of an ounce of guncotton confined in a shell of precisely the same construction and weight, the chamber being filled up with water and tightly closed, burst the shell into 121 fragments, which were violently dispersed. A corresponding charge of gun-cotton, confined in a third similar shell, the chamber being filled with air, did not burst the shell when detonated; the resulting gases found vent through a minute perforation in the plug or screw-stopper of the shell. One ounce of gun-cotton confined in a similar shell, filled up with water, broke it up into 300 fragments, but in addition there were 2 lb. 1 oz. of the shell almost pulverised by the force of the explosion brought to bear upon the metal through the agency of the confined water.

The manner in which Mr. Abel has applied this system of bursting shells is very simple. The fuse which is used in field-artillery service for bursting shrapnel-shells or the common shell (when the latter is filled with gunpowder and used as a mine or an incendiary projectile), has fitted to it a small metal cylinder closed at one end, into which is tightly packed from a quarter to one-half ounce of dry compressed gun-cotton. The open end of the cylinder is closed with a screw plug containing a small chamber filled with fulminate of mercury, the upper side of which is in close contact with the fuse when the cylinder has been attached to the latter. To employ common shells as *water-shells* it is now only necessary to fill them completely with water, and then to insert and screw down firmly the fuse with its little detonating cylinder attached, when the detonating charge is fired by the action of the fuse, the shell is instantaneously burst into a large number of fragments by the concussion transmitted by the water.

Mr. Abel's prediction that this plan of bursting shells would be found most effective, is amply borne out by the magnificent practice made by the field-guns at Okehampton. Of the two batteries of Royal Artillery which have carried on the experiments during the past week, one has done more mischief with the "water-shells" than with the delicately constructed shrapnel, with the nature of which the gunners are intimately acquainted; while with the other battery of heavier field-guns the practice made was but little inferior. A little better acquaintance on the part of artillerymen with the new system of using shells will, it is anticipated, still further increase the deadly effect of these terrible weapons. Moreover, the water-shell has hitherto only been used in conjunction with a percussion fuse, while it is with the time-fuse that the shrapnel-shell is found the most effective. With the percussion-fuse the two shells are about on an equality, while the water-shell has the advantage of greater simplicity.

NOTES FROM THE "CHALLENGER"

THE following extracts from a letter dated Yeddo, June 9, 1875, addressed to me by Prof. Wyville Thomson, will, I think, interest the readers of NATURE:—

"In a note lately published in the proceedings of the Royal Society on the nature of our soundings in the Southern Sea, I stated that up to that time we had never seen any trace of the pseudopodia ~~of Globigerina.~~ I have now to tell a different tale, for we have seen them ~~very many times, and~~ their condition and the entire appearance and behaviour of the sarcode are, in a high degree, characteristic and peculiar. When the living Globigerina is examined under very favourable circumstances; that is to say, when it can at once be transferred from the tow-net and placed under a tolerably high power in fresh, still sea-water, the sarcodic contents of the chambers may be seen to exude gradually through the pores of the shell and spread out until they form a gelatinous fringe or border round the shell, filling up the spaces among the roots of the spines and rising up a little way along their length. This external coating of sarcode is rendered very visible by the oil-globules, which are oval and of considerable size, and filled with intensely coloured secondary globules; they are drawn along by the sarcode, and may be observed, with a little care, following its spreading or contracting movements. At the same time, an infinitely delicate sheath of sarcode containing minute transparent granules, but no oil-globules, rises on each of the spines to its extremity, and may be seen creeping up one side and down the other of the spine, with the peculiar flowing movement with which we are so familiar in the pseudopodia of Gromia, and of the Radiolarians. If the cell in which the Globigerina is floating receive a sudden shock, or if a drop of some irritating liquid be added to the water, the whole mass of protoplasm retreats into the shell with great rapidity, drawing the oil-globules along with it, and the outline of the surface of the shell and of the hair-like spines is left as sharp as before the exodus of the sarcode. We are getting sketches carefully prepared of the details of this process, and either Mr. Murray or I will shortly describe it more in full. . . .

"Our soundings in the Atlantic certainly gave us the impression that the siliceous bodies, including the spicules of Sponges, the spicules and tests of Radiolarians, and the Pustules of Diatoms which occur in appreciable proportions in Globigerina ooze diminish in number, and that the more delicate of them disappear, in the transition from the calcareous ooze to the 'red clay;' and it is only by this light of later observations that we are now aware that this is by no means necessarily the case. On the 23rd of March, 1875, in the Pacific, in lat. 11° 24′ N., long. 143° 16′ E., between the Carolines and the Ladrones, we sounded in 4,574 fathoms. The bottom was what might naturally have been marked on the chart 'red clay;' it was a fine deposit, reddish brown in colour, and it contained scarcely a trace of lime. It was different, however, from the ordinary 'red clay,'—more gritty—and the lower part of the contents of the sounding tube seemed to have been compacted into a somewhat coherent cake, as if already a stage towards hardening into stone. When placed under the microscope, it was found to contain so large a proportion of the tests of Radiolarians, that Murray proposes for it the name 'Radiolarian ooze.' This observation led to the reconsideration of the deposits from the deepest soundings, and Murray thinks that he has every reason to believe (and in this I entirely agree with him) that, shortly after the 'red clay' has assumed its most characteristic form, by the removal of the calcareous matter of the shells of the Foraminifera, at a depth of say 3,000 fathoms, the deposit begins gradually to alter again by the increasing proportion of the tests of Radiolarians, until, at such extreme depths as that of the sounding of the 23rd of March, it has once more assumed the character of an almost purely organic formation, the shells of which it is mainly composed being however in this case siliceous, while in the former they were calcareous. The 'Radiolarian ooze,' although consisting chiefly of the tests of Radiolarians, contains, even in its present condition, a very considerable proportion of red clay. I believe that the explanation of this change, which was suggested by Murray, and was indeed almost a necessary sequence to his investigations, is the true one. We have every reason to believe, from a series of observations, as yet very incomplete, which have been made with the townet at different depths, that Radiolarians exist at all depths in the water of the ocean, while Foraminifera are confined to a comparatively superficial belt. At the surface and a little below it, the tow-net yields certain species; when sunk to greater depths, additional species are constantly found, and, in the deposits at the bottom, new forms occur, which are met with neither at the surface nor at intermediate depths. It would seem also that the species increase in number, and that the individuals are of larger size as the depth becomes greater; but many more observations are required before this can be stated with certainty. Now, if the belt of Foraminifera which, by their decomposition, according to our view, yield the 'red clay,' be restricted and constant in thickness, and if the Radiolaria live from the surface to the bottom, it is clear that, if the depth be enormously increased, the accumulation of the Radiolarian tests must gain upon that of the 'red clay,' and finally swamp and mask it."

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[*] Contributions to the History of Explosive Agents, Second Memoir, by F. A. Abel, F.R.S.—Phil. Trans. 1874, p. 373.

Prof. Wyville Thomson further informs me that the best efforts of the *Challenger's* staff have failed to discover *Bathybius* in a fresh state, and that it is seriously suspected that the thing to which I gave that name is little more than sulphate of lime, precipitated in a flocculent state from the sea-water by the strong alcohol in which the specimens of the deep-sea soundings which I examined were preserved.

"The strange thing is, that this inorganic precipitated is scarcely to be distinguished from precipitated albumen, and it resembles, perhaps even more closely, the proligerous pellicle on the surface of a putrescent infusion (except in the absence of all moving particles), colouring irregularly but very fully with carmine, running into patches with defined edges, and in every way comporting itself like an organic thing."

Prof. Thomson speaks very guardedly, and does not consider the fate of *Bathybius* to be as yet absolutely decided. But since I am mainly responsible for the mistake, if it be one, of introducing this singular substance into the list of living things, I think I shall err on the right side in attaching even greater weight than he does to the view which he suggests.

T. H. HUXLEY

THE INTERNATIONAL CONGRESS AND EXHIBITION OF GEOGRAPHY

AT the distribution of prizes the Ordnance Survey obtained a letter of distinction, although it was not an exhibitor. It is the only instance in which such an honour was awarded. M. Quatrefages, in the name of the governing body of the society, awarded two exceptional prizes, one to MM. Payer and Weyprecht for the discovery of Francis-Joseph Land, and the other to M. Delaporte for the foundation of the Cambodian Museum at Compiègne. Admiral la Roncière, le Nourry closed the meeting by a very impressive address reviewing the characteristics of the Congress.

The success of the Exhibition is so great that it will be kept open up to the 19th of September. The number of visitors is greater than ever now that the Congress is over, and many fresh attractions have been added to several sections. M. Buys Ballot, the director of the Utrecht Meteorological Institution, has sent a board used by him for better indicating the direction of winds and distribution of pressure. Small holes are perforated in a map at the places occupied by the several stations. In these holes are placed small needles whose height indicates the barometrical height, and whose head is an arrow showing the actual direction of the wind.

In the French annexe has been exhibited a drawing of a machine for manufacturing relief maps out of a block of plaster. The knife is movable by a kind of pantograph, and can be conducted alongside the several *lines of level* (lignes de niveau) of a map which is seen by reflection in a plate of glass placed in a suitable position.

Peter the Great having been appointed a member of the Academy of Paris in 1717, ordered a map of the Caspian Sea to be drawn, which he sent to his fellow-members of the Academy as a proof of his zeal for the progress of science, and to justify the honour which had been conferred upon him. This map was lodged in the archives of the Academy, engraved and published in the volume of 1721, with a report written by Dellile the astronomer. It happens that the same map is exhibited at the Russian annexe, and the circumstances connected with it having become generally known, it has given rise to the report that the Grand Duke Constantine will be elected a member of the Academy, like his ancestor and the Emperor of Brazil. It is something more than an idle rumour.

A banquet was given by the Section of Commercial Geography, and some resolutions were adopted *inter poculas*. The most notable is in reference to the establishment of a *fonda* in the centre of the Sahara for the use of all civilised nations. But although adopted unanimously, the motion is not likely to be carried into execution very speedily.

SCIENCE IN GERMANY

(*From German Correspondents.*)

IT was the phenomenon of the motion of glaciers which caused most of the scientific men, that studied its details, to make experiments on the behaviour of snow and ice under pressure. The brothers Von Schlagintweit and Prof. Tyndall were the first who made such experiments with regard to glacial phenomena. Later on Helmholtz described a series of investigations, which proved amongst other things that snow is changed into ice by high pressure, that ice broken into little pieces can again be pressed into a homogeneous ice cylinder, that such a cylinder can be pressed through openings of smaller diameter, &c. It was thus shown that under a strong pressure ice can be formed into any desired shape, that it behaves plastically even on a small scale, in the same way as the gigantic ice-rivers of glaciers do on a large one, adapting themselves to the narrower or wider parts of the valleys through which they flow. The phenomenon discovered by Faraday in the year 1850, which was afterwards widely discussed, and which was called regelation, formed the key for the explanation of this behaviour. Not one, however, of the men of science mentioned has tried to determine the exact pressure under which ice changes its form; all of them have worked with very high pressure, which in fact is necessary to obtain results that are visible in a short time. Only Moseley has made several series of experiments, to ascertain at what pressure or draught ice tears, is crushed, or when its plasticity becomes perceptible, *i.e.* at what pressure a dislocation of the ice-particles takes place. He found, that to tear an ice-cylinder apart, for each square inch of its base a weight of from 70 to 116 lbs. was necessary according to the higher or lower temperature (representing a pressure of 5½ to 9 atmospheres). To break an ice cylinder by pressure, 101·8 lbs. were necessary for each square inch; and to cause a dislocation of the ice-particles, from 97·89 lbs. to 118 lbs. were required (7½ to 9 atmospheres).

Herr Pfaff, of Erlangen, has lately made a series of experiments in order to obtain some more exact numerical values for the degrees of pressure which change the form of ice to any apparent extent; it is particularly interesting to know with reference to the glacier motion, what is the *minimum* of pressure at which ice still remains plastic, *i.e.* yields to pressure. It was found that even the *smallest* pressure was sufficient to dislocate ice-particles *if it acted continuously, and if the temperature of the ice and its surroundings was near the melting-point.* At a pressure of two atmospheres ice showed itself so yielding, that for instance a hollow iron cylinder of 11·5 mm. diameter and 1·7 mm. thickness of side entered 3 mm. deep into the ice within two hours, and at a temperature of between – 1° and + 0·5°. The following will show the influence of temperature. The same iron cylinder under the same pressure entered 1·25 mm. deep into the ice in twelve hours at a temperature of between – 1° and – 4°; while at a temperature varying between – 6° and – 12° it only entered 1 mm. deep in five days, at a pressure of five atmospheres, or only 0·1 mm. in twelve hours. If the temperature of the surroundings rises beyond the melting-point the ice becomes so soft that in one hour the same iron cylinder under the same low pressure entered 3 cm. deep into the ice, although it was completely surrounded by snow in order to prevent the temperature of the cylinder itself rising beyond 0°. In all these experiments a one-armed lever was used to regulate the pressure; it consisted of a steel rod of 86 cm. length, which had a boring at its end and was fastened to a steel plug round which it could easily be turned. By this simple contrivance any desired pressure could be maintained for any length of time. These and other experiments (which were made with a pressure of only ⅓ atmosphere) show that the plasticity of ice at a temperature near its melting-point is very great even at the lowest degrees of pressure. Herr Pfaff is of opinion that at this temperature the plasticity of the ice only becomes *nil* when the pressure itself is *nil*, but that it decreases very quickly as the temperature gets lower.

The opinion is still widely spread, based upon some experiments of Tyndall, that ice is not in the least flexible or ductile, although lately several observations have been made which force us to ascribe some flexibility to that substance. Kane observed, for instance, that a large slab of ice resting with its edges on two other blocks, bent itself under its own weight after a lapse of several months. Herr Pfaff experimented with a parallelopiped of ice of 52 cm. length, 2·5 cm. breadth, and 1·3 cm. thickness. It was placed with its two ends on wooden supports, so that on each side 5 mm. were resting on wood. From Feb. 8th to Feb. 15th, when the temperature remained between – 12° and – 3·5°, the middle sunk very little, on the average 2 or 3 mm. in twenty-four hours, so that on Feb. 15th the total bend amounted to 11·5 mm. Then the temperature rose but still remained under 0°; yet this rise caused a great increase in the bending, as it reached the value of 9 mm. in twenty-four hours (therefore 20·5 in all). Nowhere could any crack or tear in the ice be seen; the lower surface was examined with particular care, and did not show the trace of a crack!

Herr Pfaff has also succeeded in proving the expansion of ice by draught. It appears therefore that near its melting-point ice, like other bodies, yields to pressure and to draught, and must be looked upon, particularly with reference to the former, as an eminently plastic substance. This behaviour of ice towards pressure at different temperatures throws a new light upon the fact that the velocity in the motion of glaciers increases with temperature. As the glacier ice and the air over it possess a temperature, in the summer months at least, which lies very near the freezing point, it is evident that a very small pressure suffices to cause the glaciers to move. S. W.

At present a question is being discussed by morphologists, which seriously affects in more than one direction some traditional maxims of experience which were apparently confirmed long ago. It treats of the way and means by which cells, the foundation-stones as it were of the animal organism, are formed during the first process of the development of the ovum, viz., during its continually progressing division. The views of Remak, Kölliker, and others were generally adopted and often repeated until lately, namely, that the ripe and fertilised ovum, when it lost its former nucleus, the "germ bubble," received a new one, and that the division of this new nucleus caused that of the ovum itself; the further divisions were represented by the simple idea of a division of cells. Although Goette already, in the year 1870 ("Centralblatt für die medicinischen Wissenschaften," No. 38), and later, Bütschli ("Beiträge zur Kenntniss der freilebenden Nematoden," in "Nova acta der Leop. Carol. Deutschen Akademie der Naturforscher," 1873), and Fol ("Die erste Entwickelung des Geryonidencies; Jenaische Zeitschrift für Medicin und Naturwissenschaft," 1873) had opposed these views on the basis of new observations, yet general attention was only obtained by Auerbach in his work, "Organologische Studien" (1874), as the question at stake was treated in a more detailed manner. Auerbach examined the same animals which Bütschli had observed, viz., that order of Entozoa known as Nematoidea; he found that in their fertilised ovum, after the germ bubble has disappeared, two new nuclei are formed at two opposite poles of the ovum, which then approach each other towards the middle of the ovum and unite into *one*; this, however, soon disappears again, and a less sharply defined clear substance takes its place; this then extends longitudinally and takes a star-shaped form at each end, so that the two stars are connected by a thin stem. Now the division of the ovum begins to take place through the middle of that stem, while in each half of the same, by the confluence of little bubbles, a nucleus forms, which initiates the same phenomena for the further divisions as those which precede and accompany the first one. The result, therefore, would be as follows:—1. In the division of the ova of Nematoidea the nuclei disappear before each stage of the division, and form anew after each stage. 2. This formation takes place through the confluence of two or more bubble-shaped or nucleus-like new forms. 3. The disappearance of the nuclei is accompanied by a peculiar star-shaped formation, which Auerbach deduces from the flowing apart of the nucleus matter. Bütschli has lately published new observations on the same subject (" Siebold's und Kölliker's Zeitschrift für wissenschaftliche Zoologie," 1875), from which it must be specially pointed out that even the first nucleus of the fertilished ovum of some Nematoidea, and of the fresh-water mollusc, Limnæus, results from the confluence of several little bubbles. Flemming has found Auerbach's observations confirmed with the fresh-water shell, Anodonta ("Archiv für mikroskopische Anatomie," band x., and " Sitzungsberichte der Akademie der Wissenschaften zu Wien III. Abtheilung," 1875"); he only differs so far from Auerbach in the interpretation of what he saw, that he does not deduce the "carpolytical figures" of the latter from the nucleus matter which radiates from the centre of the nucleus, but from a peculiar structure in the surrounding yolk-protoplasm, which he considers to be in connection with each division of the yolk and the new formation of the nuclei. But he does not interpret the process of this new formation. Flemming, in his second paper, describes the observations on a radiated arrangement of the yolk, which had previously been made occasionally with several other animals, without the observers being able to explain these phenomena or trying to investigate them further. We must, however, remark here that Goette, in the work we mentioned in our last report, has not only completely described the interior process of the division of the ovum of *Reptilia*, but has also attempted a uniform explanation of the same. According to his experience no nuclei at all are formed for some time in the division parts of the yolk, but only nuclei-shaped interior transformation products of the yolk, which are only apparently separated from their surroundings, but are in reality in continuous connection with them. These interior formations originate as collecting points of a radiated and universal protoplasm current in the yolk, which in turn results from the reciprocal action of the ovum and the surrounding medium. The difference in the currents is said to cause (in a manner described in detail) the division of these interior formations, and, as a consequence, the division of the surrounding yolk material. The radiated arrangement of the latter round the brighter centres is only imperfectly visible in *Batrachia*; but Goette has observed it in the ova of *Ascidia*, and interpreted it in the way just described. The definite nuclei of embryo cells, which result immediately from the division of the yolk, Goette supposes to be formed within those centres from a number of grains, which are at first greatly augmented, and then finally unite completely. But these origins of the nuclei do not disappear during the divisions of the yolk. If now we compare all the observations mentioned, we first of all find them all agreeing *that the division of the yolk is no simple cell division*, such as is elsewhere found in the tissues of developed organisms; for the remainder, the observations do not agree. While Goette supposes a gradual and continual progress of the formation of cells beginning from the first division, the other observers incline to the belief that at each division an interruption and a consequent re-beginning of the formation of cells takes place, as the once formed nuclei are said to disappear continually and new ones are said to form.

NOTES

THE U.S. Government have just shown in a handsome manner their appreciation of the services rendered by Dr. Henry Draper in connection with the U.S. observation of the recent Transit of Venus, by presenting him with a gold medal made at the U.S. Mint at Philadelphia. On the obverse is the motto, from Virgil, "Famam extendere factis hoc virtutis opus est," and in the centre a figure of the heliostat which was used by Dr. Draper in training the photographers. On the reverse is the inscription, "Veneris in sole spectandæ curatores, R. P. F. S. Henrico Draper, M.D., Dec. viii. MDCCCLXXIV." The phrase around the edge of the reverse, "Decori decus addit avito," conveys a tribute of praise to the literary and scientific attainments of Dr. Draper, sen. The Transit Commission have also sent Dr. Draper a handsomely bound set of resolutions illuminated in mediæval style, with a telescope, camera, &c. We are sure all scientific men will join in congratulating Dr. Draper on his well-deserved honour, and at the same time the U.S. Government on their enlightenment in thus acknowledging the glory which the triumphs of pure science have shed upon a nation; they have set a striking example to our own and other European Governments.

THE fifth session of the French Association for the Advancement of Science, as we intimated in our last number, will be opened to-day at Nantes. The principal attraction will be the excursions; one of them will last for more than three days, a war-steamer having been placed at the service of the Association by the Minister of Marine. The excursionists will visit Vannes and its prehistorical museums, the megalithic monuments of Locmariaques, the celebrated remains at Carnac, the sland of Belle-ile, and Lorient. No doubt there will be a great rush for the excursion. The list of papers to be read is a very long one. In the Mathematical Section a large number of the papers are on engineering subjects, and in the Natural Science Section a large proportion are on medical subjects, besides a good many on prehistoric archæology. Among the latter class are the following:—Dr. Broca, On the anthropology of Brittany; The Dolmens of the Lozère, by Dr. Prunières; On the funeral rites of prehistoric times in Scandinavia, by M. Waldemar-Schmidt. Other papers in this section are: On a new elementary theory of botany, by Dr. Ecorchard; On the meaning which it is proper to attach to the word "Mollusc" as a taxonomic term, and On the organisation of Rhizomes, by Dr. Gulland; On the Fauna of the Lake of Tiberias, by Dr. Lortet; On the pressure and rate of the blood in the arteries, by M. Marey. In the Section of Physical and Chemical Sciences we note the following:—On Microzymes in their relation to fermentation and physiology, On two new principles of wine, and On the origin of Bacteria, by Prof. Béchamp; Experiments on the rate of light between the Paris Observatory and Montlhéry, by M. A. Cornu; On the use of the spectroscope in the manufacture of Bessemer steel, by M. V. Deshayes; The meteorology and physics of the Polar Regions, by the Abbé Durand; On molecular combinations, by M. C. Friedel; On the limits of permanent snow and ice on the surface of the globe, On a magneto-dynamic galvanoscope, and On the chemical constitution of albuminoid matters, by M. P. Schützenberger; On a polymer of the oxide of ethylene, and on the dissociation of the salts of aniline, by M. A. Wurtz. There will be two public lectures—one by Prof. Bureau, of the Paris Museum, On the Natural Sciences at Nantes, and the other, On Acoustics—the *timbre* of sounds, by Dr. Gavarret.

THE above Association is not the only French institution which was created after the model of the British Association. M. de Caumont, who died four years ago, instituted another annual scientific congress, which will hold its forty-first session at Perigueux, in the department of Dordogne. Every year this association meets in a provincial town during summer, and at Paris during the recess of Easter. The members are mostly Legitimists and Roman Catholics.

THE forty-eighth meeting of the German Scientific and Medical Association will commence this year on the 17th of September at Graz (Austria). The two branches will be presided over by Drs. Rollet and von Tebal of that University, who have issued the following programme: Sept. 17, 8 P.M.—Preliminary Meeting. Sept. 18, 10 A.M.—First General Meeting; 1 P.M.—Sectional Meetings; 8 P.M.—Reunion; Sept. 19.—Excursion to the Castle, Sectional Meetings, Evening Concert at the Theatre. Sept. 20.—Sectional Meetings and Excursions. Sept. 21.—Second General Meeting, Sectional Meetings, Festive Performance in two Theatres. Sept. 22.—Excursions. Sept. 23.—Sectional Meetings, Banquet. Sept. 24.—Third and Concluding General Meeting, Ball. The Sections will be divided as follows: (1) Mathematics and Astronomy. (2) Natural Philosophy and Meteorology. (3) Chemistry. (4) Mineralogy, Geology, and Palæontology. (5) Botany. (6) Zoology. (7) Anatomy and Physiology. (8) Medicine. (9) Surgery. (10) Ophthalmology and Otiatry. (11) Midwifery. (12) Psychiatry. (13) Public Health. (14) Military Surgery. (15) General Pathology. (16) The Teaching of Science. (17) Agriculture.

A CONGRESS has been held at Nancy on the history, archæology, and languages of the American continent. The city was illuminated, and a banquet was given by the municipality to the foreign members of the Congress. A most interesting exhibition took place, principally of American stone implements, Peruvian mummies, Columbian idols, and skulls of a number of the aborigines. The Congress discussed the questions relating to the discovery of America before Columbus, by Norwegians, Phœnicians, and Buddhists, and did not appear inclined to believe in the reality of any of the traditions. There were also discussed at some length the relations of Esquimaux tribes with those of Northern Asia, traditions as to white men, the monuments of the Mississippi Valley, and the rock inscriptions, without coming to any definite conclusions.

THE observation of meteors has been organised in France by the Association Scientifique under M. Leverrier; this organisation numbers more than 6,000 members, but has no annual meeting. About forty stations keep watch on critical nights. The results of the observations during the time of the August shower have been unusually good. At Rochefort and Rouen alone more than 160 tracks were mapped during the nights of the 9th and 10th of August, mostly connected with the Perseus radiant.

THE preparations for the Scientific and Agricultural Congress at Palermo on the 29th inst. are proceeding with unabated activity. Many *savants*, particularly from Germany, have intimated their intention to assist at the proceedings. Father Secchi will preside in the department of Astronomy.

FROM observations made upon the Manatee living in the Zoological Gardens, Regent's Park, the Society's Prosector has had the opportunity of presenting a paper to be read during the next session of the Scientific Committee of the Society, on the peculiar prehensile power of the upper lip of that animal, by which it seizes its food between the two lateral bristle-covered pads with which that organ is provided, and which it can move laterally.

THE *Journal of Anatomy and Physiology*, which till now has done much service to biologists under the able editorship of Prof. Humphry, of Cambridge, and Prof. Turner, of Edinburgh, is to be further strengthened in the Physiological Section by the extra editorial assistance of Dr. Michael Foster, of Cambridge, and Prof. Rutherford, of Edinburgh. The journal is also to appear quarterly, not half-yearly, as heretofore.

THE Transactions of the Zoological Society, vol. ix. Part iv., just issued, comprises a memoir, by Mr. Sclater, F.R.S., "On the Curassows now or lately living in the Society's Gardens." It is illustrated with thirteen coloured quarto plates from the pencil of Mr. Smit, and forms a complete monograph of all the known species of true curassows.

M. E. MULSANT, Conservator of the Library of the City of Lyons, is on a visit to this country for the purpose of examining Messrs. Salvin and Godman's, as well as other collections of birds, in order to render more complete his "Histoire Naturelle des Oiseaux-Mouches," now in course of publication.

CAPT. BURTON and party have just returned from Iceland. The immediate object of the visit was to examine the extensive sulphur mines which were worked in the north-eastern part of the island about the beginning of the present century, and for the reopening of which a company has recently been formed. The result of the visit seems in this respect to have been satisfactory. Mr. W. L. Watts met Capt. Burton's party, just after he had performed the remarkable feat of crossing the Vatna Jokul, an immense snowy table-land in the S.E. corner of the island. Mr. Watts has been the first to accomplish this feat.

IN the note concerning a shower of hay in Denbighshire in last week's NATURE, p. 298, we omitted to say that the year in which the occurrence took place was 1857.

THIS year's meeting of the British Archæological Association was opened at Evesham on Monday by the President, the Marquis of Hertford, who reviewed the several points of interest which the Association intended to visit in Warwickshire and Worcestershire.

THE most important paper in the July number of the *Bulletin* of the French Geographical Society is on the geography of the Athabasca-Mackenzie region, by the Abbé E. Petitot, who has spent twelve years as a missionary in that inhospitable portion of North America, making many journeys to all parts of the district indicated, lying between the Coppermine River and the Rocky Mountains, and the Great Slave Lake and the Arctic Ocean. The Abbé gives a brief *résumé* of discovery in this region, and a short sketch of the various journeys he himself made, to be followed by further details. An excellent map accompanies the narrative, and although the explorer's instruments were rather scanty, it is evident that he has added largely to our knowledge of the geography of the district of country referred to.

ANOTHER interesting paper in the same number is on the Lyssous of Lin-tze-Kiang, by another missionary, the Abbé Dubernard. It is notable how large a number of French explorers have been missionaries.

A RETURN has been presented to Parliament giving a statement of all the weather telegrams issued by the Meteorological Office, and also of all the storms experienced on the coasts of the British Islands during 1874, from which it appears that of the warnings issued, 78·2 per cent. were justified by subsequent gales or strong winds, and that 16·4 per cent. were not justified by the subsequent weather. This percentage of success in the warnings issued, which is slightly in excess of the last two years' of Fitzroy's management, considerably in excess of 1870 and 1871, and about equal to the results for 1872 and 1873, is perhaps as good as may reasonably be expected until the system be further extended and developed.

WE have received a circular calling attention to the success attending the working of Dr. Herman Sprengel's improvement in the manufacture of sulphuric acid. The process was patented in 1873, and consists in injecting water in the form of spray into the chambers instead of steam. To effect this a jet of steam escapes from a platinum nozzle at a pressure of about two pounds, and blows through the centre of a flowing jet of water by means of an apparatus similar in principle to Herapath's blow-pipe. These jets are let into the side of the chamber at distances of 40 feet. The advantages gained are economy of fuel, nitric acid, and pyrites. The method has been in use at the works of the "Lawes Chemical Manure Company" at Barking, and the returns show that a saving of coal to the amount of $\frac{2}{3}$ of the quantity formerly burned has been effected—the total saving in steam, nitric acid, and labour during three months, amounting to five shillings per ton of acid of sp. gr. 1·6 made from pyrites. The patentee just points out that a saving of even one shilling per ton means in this country an annual gain of 50,000*l*.

THE Rev. N. M. Ferrers, of Cambridge, author of "A Treatise on Trilinear Co-ordinates," is preparing for the press a work on Spherical Harmonics. The plan adopted in this work will be first to discuss thoroughly the properties of the Zonal Harmonic, for which various expressions will be given, and general formulæ investigated, by which any rational integral function of one independent variable may be expressed in a series of Zonal Harmonics. The properties of Tesseral and Sectorial Harmonics will then be deduced from these. The expression of a discontinuous function by means of Spherical Harmonics will be discussed; and various examples will be given of the use of Spherical Harmonics in their applications to the theories of attraction, and of electricity and magnetism. The book will be published by Messrs. Macmillan and Co.

"PYTHAGOREAN Triangles" is the title of a paper which was read by W. Allen Whitworth, M.A., before the Literary and Philosophical Society of Liverpool in February of the present year. A Pythagorean triangle is a right-angled triangle having all its sides commensurable. The most familiar instance is that triangle whose sides are in the ratio of the numbers 3, 4, 5. The author shows that one of the sides must be even (a multiple of 4), one a multiple of 3, and that either a side or the hypotenuse must be divisible by 5. Making use of a discovery of Fermat's, he further shows that every prime number of the form $4N + 1$ is the hypotenuse of such a triangle. The most general results obtained are "the product of n prime hypotenuses, all different, will be itself the hypotenuse of 2^{n-1} Pythagorean triangles;" this result is modified if m only are different, to 2^{m-1} Pythagorean triangles. With the aid of these results he presents, in a tabulated form, 395 such triangles, with hypotenuses less than 2,500. We may mention that in Tebay's Mensuration a table of some 200 of these triangles is given, but with no indication as to how they are obtained. A great deal of information on the subject of these triangles is given in vol. xx. of "Mathematics from the *Educational Times*," at pp. 20, 54, 75, 76, 87, 97–100, to which we refer such of our readers as may be interested in the matter.

THE West Riding Consolidated Naturalists' Society have published the first number of a new monthly journal, the *Naturalist*. A journal with a similar title was published in the same district during the years 1865-6-7; we hope the present one will have a much longer life. Its principal object is to afford a means of communication among all Natural History Societies, either within or outside the county of York.

FROM the fourth Annual Report of the Chester Society of Natural Science, we are glad to see that the Society is prosperous and in good working order. The members now number 541, and during the past year several excursions have been made, several general meetings held for lectures, and the regular work of the sections carried on. Altogether this Society seems in a hopeful condition. The same Report contains a brief report of the Wrexham Society of Natural Science, which seems to some extent to be under the fostering care of its more prosperous Chester sister. It seems to be, on the whole, doing well.

MAJOR WOOD has sent us a reprint of two papers, with a map, on the Aralo-Caspian region; they originally appeared in the *Globe*, the journal of the Geographical Society of Geneva. Ramboz and Schuchardt, of Geneva, are the publishers.

THE additions to the Zoological Society's Gardens during the past week include a Red Deer (*Cervus elaphus*), European, presented by Mr. Samuel Carter; a Malabar Squirrel (*Sciurus maximus*) from S. India, presented by the Chevalier Blondin; two Purple Cow Birds (*Molothrus purpureus*) from Peru, presented by Prof. W. Nation; a Yellow-fronted Amazon (*Chrysotis ochrocephala*) from Guiana, presented by Mrs. Bolton; a Crested Peacock Pheasant (*Polyplectron chinquis*) from Malacca, purchased; three Hoffmann's Sloths (*Cholopus hoffmanni*) from Panama; three Spotted Cavies (*Cœlogenys paca*), a Coypu (*Myopotamus coypus*) from S. America, an Argus Pheasant (*Argus giganteus*) from Malacca, deposited.

ON THE ACTION OF URARI ON THE CENTRAL NERVOUS SYSTEM

SINCE the introduction of urari twenty years back it has become more and more employed as an anæsthetic for physiological experiments. Its effects on the peripheral portions of the nervous system have been carefully studied, and are most distinct and peculiar, so much so that they seem to have diverted attention from its action on the central organs. Its effect, briefly, when injected subcutaneously, is to produce a paralysis of the motor nerves by attacking their ultimate branches. Dr. Foster, at whose suggestion these experiments were undertaken, and to whom I am indebted for much assistance, in the "Handbook for the Physiological Laboratory" establishes the following propositions:—1. "The effect of urari is to destroy or suspend the irritability of nerves, but not of muscles." 2. "With moderate doses of urari the small branches appear to be poisoned and to have lost their irritability, while the trunks are still intact." He also points out that "in order to bring these results out well, the dose of poison must not be more than sufficient to poison the motor nerves. Subsequent or stronger action of the poison affects the central nervous system as well." Now it is perfectly clear that the poison produces no appreciable effect on the sensory nerves, and in consequence rash conclusions have been drawn that it also has no effect on the sensorium, and is, in fact, not an anæsthetic at all.

The method of investigation employed was to take two frogs, as nearly as possible alike in size and vigour, and to pass a ligature round the whole abdomen (on Bernard's plan), taking care to exclude from the ligature the sciatic plexus and to include the blood-vessels. To one of the frogs a dose of urari was then administered, and the two placed under similar conditions and watched. The ligature in the poisoned frog of course prevented the urari from gaining access to the hinder limbs, while it could act fully on the nerve centres; and the behaviour of this frog could be compared with one which had merely undergone the operation, and was clearly possessed of consciousness and volition. We will call the two frogs A and B, B being the one which has the dose of urari. Now as soon as the poison took effect, movements of respiration of course ceased, and the frog lost control over its fore-limbs. On placing them side by side in an unconstrained position, A constantly moved, executing large and small movements with precision; its actions seemed in no way different from those of an uninjured frog. During this time the frog B never moved, and although quite capable of using its hind limbs, never did so; at rare intervals (perhaps half an hour), however, a movement was executed, but of a very distinct kind, a mere kick, such as a frog gives after the removal of its brain, in virtue of pure reflex action; now the innervation of the hind limbs was quite intact; the animal, if possessed of any wish to move them, was quite able to do so, so far as its structural arrangements were concerned. Indeed, the frog bore a striking resemblance to one which had had its brain removed; it behaved in almost every respect in the same manner.

If the two frogs be now laid on their face, a most convincing experiment can now be tried. If the leg of A be forcibly extended and let go, it is drawn up; if it be extended and held for a short time, it is again drawn up. Now if the leg of B be extended and at once released, it is also drawn up; but if it be held for a second against the efforts of the animal to withdraw it, these efforts cease and the limb retains its position for an almost indefinite period. Now there can be only one explanation of the behaviour of the frog B, namely, that the urari destroys consciousness and volition at an early period; that on extending the hind limb the mere act of extension is sufficient stimulus to call forth a definite amount of response which takes the form of a simple contraction, but that if the limb be held until this reflex act has passed off there is no consciousness on the part of the brain that the limb is in an unusual position, and consequently no volition is exerted to remove it.

It cannot be objected to this experiment that the stoppage of the circulation in the hind limbs has diminished their irritability because the frog A has perfect control over his; and, moreover, the vigour with which the reflex acts are executed in B precludes this idea. Again, it might be said that the stoppage of the respiration by the urari, and consequent supply of ill-aërated blood to the brain has injured the volition of the animal; to meet this, two counter experiments have been tried: in one a frog was gagged so as to keep its mouth open for some hours, and in the other a frog was kept under well-aërated water for two hours (a period equal to the duration of the chief experiment), and in neither case did the frogs seem to suffer any inconvenience whatever, least of all did they lose their volition.

In order to investigate the action of urari on the spinal cord, two similar frogs were taken as before; but previously to being ligatured they were pithed and had their brains destroyed; they were then suspended, and the state of the cord, as manifested by reflex action, tested; dilute sulphuric acid was used as stimulus; the numbers represent quarter seconds.

	h. m.		A*		B	
α	3 30	...	9	...	8	
	3 35	...	7	...	6	
	3 40	...	8	...	6	
			A* Lost blood.			
β	3 40	Urari was given to B.				
	4 15	...	8	...	5	
	4 20	...	8	...	7	
	4 25	...	8	...	6	
	4 30	...	8	...	8	
	4 35	...	9	...	9	
γ	4 35	A second dose to B.				
	4 40	...	7	...	14	
	4 45	...	8	...	26	
	4 50	...	9	...	22	
	4 55	...	7	...	27	Not strong.
	5 0	...	9	...	60	Weak.
	5 5	...	8	...	No action after 220.	
	5 10	...		...		

From this it would appear that the first effect of urari is to make the action of the cord uncertain, then to delay the reflex action, and finally to destroy it entirely. The table has been divided into three parts, α, β, and γ, which seem to represent in a tolerably typical manner the three stages into which the phenomena are always divisible; sometimes the animal recovered after the stage γ.

This short account of the above experiments is intended as a preliminary notice. I am continuing investigations on mammals, and purpose hereafter to publish a more complete account of my results.

C. YULE

Physiological Laboratory, Cambridge

P.S.—Since writing the above my attention has been called to a paper by Dr. J. Steiner, in *Reichart's und Du Bois-Raymond's Archiv* for July. He investigates the action of urari on Invertebrates and fishes, and finds that among the latter its effect is to destroy volition before the peripheral motor fibres are attacked.

WEATHER AND EPIDEMICS OF SCARLET FEVER IN LONDON DURING THE PAST THIRTY-FIVE YEARS*

THIS paper gives the results of an investigation, the purpose of which was to determine whether the seasonal influence of weather on deaths from scarlet fever, as shown by the curve constructed from the figures of thirty years, would present itself if the period were broken up and curves constructed for the several smaller periods embraced in the long one. In other words, the object was to determine whether, in the case of a disease which is strongly epidemic, the obedience to seasonal influences, would exhibit a steadiness and uniformity of character, such as is presented in the case of pulmonary diseases. In London there have been six epidemics of scarlet fever during the last thirty-five years, reaching their maxima in 1844, 1848, 1854, 1859, 1863, and 1870. Curves were constructed representing the average weekly deaths from scarlet fever for each of the six periods embracing these epidemics. These curves were then compared with the curve for the thirty years, 1845–74, the leading features of which are that it is above the average from the beginning of September to the end of the year, and below the average during the rest of the year; and that the period of highest death-rate is from the beginning of October to the end of November, when it rises to about 60 per cent. above the average, and the period of lowest death-rate in March, April, and May, when it is about 33 per cent. below the average.

On comparing the curves for the six short portions of the thirty-five years, each dealing only with four, five, or six years, with the general curve for the long period of thirty years, a remarkable similarity is found to occur. They are all substantially the same curve. The description of the general curve given above applies almost literally to every one of the six curves for short periods, and indeed so close is the correspondence that they all cross their mean almost in the same week of the year. In every case the maximum occurs in October and November, and the only point of difference among them is that while the general curve rises at the maximum period to 60 per cent. above the average, during the first epidemic it rose only to 40 per cent., and in one or two of the others it rose to 80 per cent. above the average. The steady obedience to climatic influences in the fatality from a disease so decidedly epidemic as scarlet fever is very remarkable, and the more so inasmuch as no other disease, with the single exception of typhoid fever, attains to its maximum fatality in London under the conditions of weather peculiar to October and November.

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* Abstract of a paper read by Dr. Arthur Mitchell at the general meeting of the Scottish Meteorological Society, July 13.

PHYSICAL PROPERTIES OF MATTER IN THE LIQUID AND GASEOUS STATES*

II.

Law of Gay-Lussac.—That the law of Gay-Lussac in the case of the so-called permanent gases, or in general terms of gases greatly above their critical points, holds good at least at ordinary pressures, within the limits of experimental error, is highly probable from the experiments of Regnault; but the results I have obtained with carbonic acid will show that this law, like that of Boyle, is true only in certain limiting conditions of gaseous matter, and that it wholly fails in others. It will be shown that not only does the coefficient of expansion change rapidly with the pressure, but that, *the pressure or volume remaining constant, the coefficient changes with the temperature.* The latter result was first obtained from a set of preliminary experiments, in which the expansion of carbonic acid under a pressure of seventeen atmospheres was observed at 4°, 20°, and 54°; and it has since been fully confirmed by a large number of experiments made at different pressures and well-defined temperatures. These experiments were conducted by the two methods commonly known as the method of constant pressure and the method of constant volume. The two methods, except in the limiting conditions, do not give the same values for the coefficient of expansion; but they agree in this respect, that at high pressures the value of that coefficient changes with the temperature. While I have confined this statement to the actual results of experiment, I have no doubt that future observations will discover, in the case, at least, of such gases as carbonic acid, a similar but smaller change in the value of the co-efficient for heat at low pressures. The numerous experiments I have made on this subject will shortly be communicated in detail to the Society; and for the present I will only give the following results:—

Expansion of Heat of Carbonic Acid Gas under high pressures.

Pressure. at.		Vol. CO_2 at o_2 and 760 millims. = 1.		Vol. CO_2 at. 6°·05 and 22·26 at. = 1.		Temperature.	
22·26	......	0·03934	......	1·0000	......	6·05	...(A)
22·26	......	0·05183	.. ...	1·3175	......	63·79	
22·26	. ...	0·05909	... ..	1·5020	.....	100·10	

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* "Preliminary Notice of further Researches on the Physical Properties of Matter in the Liquid and Gaseous States under varied conditions of Pressure and Temperature." Paper read before the Royal Society by Dr. Andrews, F.R.S., Vice-President of Queen's College, Belfast. Continued from p. 301.

Pressure. at.	Vol. CO. at 0° & 760 millims. = 1.	Vol. CO_2 at 6°·62 and 31·06 at. = 1.	Temperature.	
31·06	0·02589	1·0000	6°·62	(B)
31·06	0·03600	1·3905	63·83	
31·06	0·04160	1·6068	100·64	

Pressure. at.	Vol. CO_2 at 0° and 760 millims. = 1.	Vol. CO_2 at. 6°.01 and 40·06 at = 1.	Temperature.	
40·06	0·01744	1·0000	6°·01	(C)
40·06	0·02697	1·5464	63·64	
40·06	0·03161	1·8123	100·60	

Taking as unit 1 vol. of carbonic acid at 6°·05 and 22·26 atmospheres, we obtain from series A the following values for the coefficient of heat for different ranges of temperature :—

$\alpha = 0·005499$ from 6°·05 to 63°·79
$\alpha = 0·005081$ from 63°·79 to 100°·1

From series B, with the corresponding unit volume at 6°·62 and 31°·06 atmospheres, we find :—

$\alpha = 0·006826$ from 6°·62 to 63°·83
$\alpha = 0·005876$ from 63°·83 to 100°·64

And in like manner from series C with the unit volume at 6°·01 and 40·06 atmospheres :—

$\alpha = 0·009481$ from 6°·01 to 63°·64
$\alpha = 0·007194$ from 63°·64 to 100°·60

The co-efficient of carbonic acid under one atmosphere referred to a unit volume at 6° is

$\alpha = 0·003629$

From these experiments it appears that the co-efficient of expansion increases rapidly with the pressure. Between the temperatures of 6° and 64° it is once and a half as great under 22 atmospheres, and more than two and a half times as great under 40 atmospheres, as at the pressure of 1 atmosphere. Still more important is the change in the value of the co-efficient at different parts of the thermometric scale, the pressure remaining the same. An inspection of the figures will also show that this change of value at different temperatures increases with the pressure.

Another interesting question, and one of great importance in reference to the laws of molecular action, is the relation between the elastic forces of a gas at different temperatures while the volume remains constant. The experiments which I have made in this part of the inquiry are only preliminary, and were performed not with pure carbonic acid, but with a mixture of about 11 volumes of carbonic acid and 1 volume of air. It will be convenient, for the sake of comparison, to calculate, as is usually done, the values of α from these experiments; but it must be remembered that α here represents no longer a coefficient of volume, but a coefficient of elastic force.

Elastic force of a mixture of 11 vol. CO_2 and 1 vol. air heated under a constant volume to different temperatures.

Vol. CO_2.	Temperature.	Elastic Force. at.	
366·1	13°·70	22·90	(A)
366·2	40·63	25·74	
366·2	99·73	31·65	
256·8	13·70	31·18	(B)
256·8	40·66	35·44	
256·8	99·75	44·29	

From series A we deduce for a unit at 13°·70 and 22°·90 atmospheres :—

$\alpha = 0·004604$ from 13°·70 to 40°·63
$\alpha = 0·004367$ from 40°·63 to 99°·73

And from series B :—

$\alpha = 0·005067$ from 13°·70 to 40°·66
$\alpha = 0·004804$ from 40°·66 to 99°·75

The coefficient at 13°·70 and 1 atmosphere is

$\alpha = 0·003513$

It is clear that the changes in the values of α, calculated from the elastic forces under a constant volume, are in the same direction as those already deduced from the expansion of the gas under a constant pressure. The value of α increases with the pressure, and it is greater at lower than at higher temperatures. But a remarkable relation exists between the coefficients in the present case which does not exist between the coefficients obtained from the expansion of the gas. The values of α, deduced for the same range of temperature from the elastic forces at different pressures, are directly proportional to one another. We have, in short—

$$\frac{0·004367}{0.004604} = 0·9485, \qquad \frac{0·04804}{0·05067} = 0·9481.$$

How far this relation will be found to exist under other conditions of temperature and pressure will appear when experiments now in progress are brought to a conclusion.

Law of Dalton.—This law, as originally enunciated by its author, is, that the particles of one gas possess no repulsive or attractive power with regard to the particles of another. "Oxygen gas," he states, "azotic gas, hydrogenous gas, carbonic acid gas, aqueous vapour, and probably several other elastic fluids may exist in company under any pressure and at any temperature without any regard to their specific gravities, and without any pressure upon one another." The experiments which I have made on mixtures of carbonic acid and nitrogen have occupied a larger portion of time than all I have yet referred to. They have been carried to the great pressure of 283·9 atmospheres, as measured in glass tubes by a hydrogen manometer, at which pressure a mixture of three volumes carbonic acid and four volumes nitrogen was reduced at 7°·6 to $\frac{1}{378}$ of its volume without liquefaction of the carbonic acid. As this note has already extended to an unusual length, I will not now attempt to give an analysis of these experiments, but shall briefly state their general results. The most important of these results is *the lowering of the critical point by admixture with a non-condensable gas.* Thus in the mixture mentioned above of carbonic acid and nitrogen, no liquid was formed at any pressure till the temperature was reduced below − 20° C. Even the addition of only $\frac{1}{10}$ of its volume of air or nitrogen to carbonic acid gas will lower the critical point several degrees. Finally, these experiments leave no doubt that the law of Dalton entirely fails under high pressures, where one of the gases is at a temperature not greatly above its critical point. The anomalies observed in the tension of the vapour of water, when alone and when mixed with air, find their real explanation in the fact that the law of Dalton is only approximately true in the case of mixtures of air and aqueous vapour at the ordinary pressure and temperature of the atmosphere, and do not depend, as has been alleged, on any disturbing influence produced by a hygroscopic action of the sides of the containing vessel. The law of Dalton, in short, like the laws of Boyle and Gay-Lussac, only holds good in the case of gaseous bodies which are at feeble pressures and at temperatures greatly above their critical points. Under other conditions these laws are interfered with; and in certain conditions (such as some of those described in this note) the interfering causes become so powerful as practically to efface them.

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, Nos. 5 and 6.—These parts contain the following papers:—No. 5: On the variations in the phases of light when reflected from glass, by P. Glan; account of experiments made in the physical laboratory of Berlin University, under the direction of Prof. Helmholtz.—On some remarkable growths of quartz crystals on calcareous spar from Schneeberg in Saxony, by Aug. Frenzel of Freiberg, and G. vom Rath of Bonn.—Mineralogical researches, by G. vom Rath. This paper treats of pseudomorphous monticellite from Pesmeda, on the Monzoni Mountain in Tyrol, of rhombic sulphur, of calcareous spar from Ahren (Tyrol), and of a peculiar specimen of quartz from Japan.—On a method to determine extra currents electroscopically, by Dr. F. Fuchs.—On the electric conduction resistance of air, by A. Oberbeck.—On the absorption and refraction of light in metallic opaque bodies, by W. Werniche.—On the changes which take place in temperature at the passage of an electric current from one metal to another, by Dr. Heinr. Buff.—On the isodynamical planes round a vertical magnetic rod, and their application in an investigation of iron ore deposits, based upon magnetic measurements, by Rob. Thalén.—A paper on the same subject, by Th. Dang. Both these papers are from the *Kongl. Vetenskaps Förhandlingar.*—Spectroscopic Notes, by J. Norman Lockyer: On the evidence of variation in molecular structure, and On the molecular structure of vapours in connection with their densities. These Notes are translated from the Proceedings of the Royal Society, June 11, 1874.—On the distribution of heat in the normal spectrum, by G. Lundquist.—On the time of attraction and repulsion of electro-magnets, by Dr. Schneebeli.—On the mathematical determination of the places of deviation in telegraph lines, by Fr. Schaak. Experiments on the plasticity of ice, by Prof. F. Pfaff. These experiments have been minutely described under our heading "Science in Germany." On the behaviour of certain fluorescent bodies towards oleum ricini, by Ch. Horner.—On a new source of magnetism, by Donato Tommasi.—No. 6: On the temporary course of the polarisation current, by Prof. J. Bernstein.—On the objections raised against Weber's law by Tait, Thomson, and Helmholtz, by C. Neumann.—Researches in spectrum analysis, by R. Bunsen. This paper will also appear in detailed extract under our heading "Science in Germany."—On the evidence of alternation of electricity by means of flames, by F. Fuchs.—On the variations in the phases of light when reflected from glass, by P. Glan (second paper).—On the theory of laying and examining submarine telegraph lines, by W. Siemens.—Researches on the magnetism of steel rods, by C. Fromme.—On the permanently magnetic moments of magnetic rods and Hacker's formula: $T = \rho \sqrt[3]{Q} \times \sqrt[6]{l}$, by L. Külp.—On the influence of the texture of iron on its magnetism, by the same.—On the passage of gases through thin layers of liquids, by F. Exner.

THE *Naturforscher*, June.—From this part we note the following papers:—On some phenomena of interference in circular nets, by M. Soret.—On the simultaneous formation of two microscopic minerals, by H. Fischer.—On the distortion of the images reflected from the surface of water, with reference to some phenomena observed on Lake Leman, by Ch. Dufour.—On the power of diffusion in the soil of fields, by M. Grandeau.—On the tenor of carbonic acid in the soil-gases of Klausenburg, by J. von Fodor.—On the formation of the "terra rossa" from the shells of Globigerina, by M. Neumayr. On a strange dimorphism among walnut trees (*Juglans regia*), by F. Delpino.—On the exhalation of carbonic acid by different animals, by Rud. Pott.—On a new source of magnetism, by Donato Tommasi.—On some physical properties of collodion films, by E. Gripon.—On the influence of oxygen upon life; experiments made with frogs which were placed in an atmosphere of nitrogen for some time, by E. Pflüger.—On the action of coloured light upon the assimilation of the mineral matter in plants, by Rud. Weber.—On the principle of the dispersion of energy, by A. Fick.—Light and electro-magnetism, by Ludw. Boltzmann.—On the nitro compounds of the fatty series, by Victor Meyer (a long paper taken from Liebig's *Annalen der Chemie*).—On hearing with two ears, by F. P. le Roux.—On the adaption-power of fresh-water molluscs breathing by lungs, by Th. von Siebold.

Journal of the Franklin Institute, June.—The following are the principal original articles in this number:—"The Centennial Exhibition," with three plates.—"Account of some Experiments made for the purpose of comparing the indication of Cassella's Air Metres," by C. B. Richards, M.E.; these experiments were adverse to the trustworthiness of the metres.—"Sympathetic Vibration," by H. A. Rowland, C.E.—"A new Vertical-Lantern Galvanometer," by Prof. G. F. Barker.—"The rapid Corrosion of Iron in Railway Bridges," by W. Kent.—"Molecular Changes in Metals," by Prof. R. H. Thurston.

Proceedings of the Bristol Naturalists' Society. New edition, vol. i. Part 2.—The first thing that strikes one on opening this part of the Bristol Society's *Proceedings* is the number of *errata*, there being a list of about eighty mistakes which have been allowed to slip into this and the previous number; this is very bad. The following are the titles of the papers contained in this part:—"On Fish Remains in the Bristol Old Red Sandstone," by S. Martyn, M.D.; "On *Ceratodus Forsteri*," by W. W. Stoddart, F.G.S.; "On the Physical Theory of Under-currents and of Oceanic Circulation," by W. Lant Carpenter, B.A., B.Sc.; "Bristol Rotifers: their Haunts and Habits," by C. Hudson, LL.D.; "Notes on Trias Dykes," by E. B. Tawney, F.G.S.; "Notes on the Radstock Lias," by E. B. Tawney, F.G.S.; "On the Geological Distribution of some of the Bristol Mosses," by W. W. Stoddart, F.G.S.; "A Contribution to the Theory of the Microscope and of Microscopic Vision. After Dr. E. Abbe, Professor in Jena," by H. E. Fripp, M.D.; "The Geology of the Bristol Coal-field (Part II.)," by W. W. Stoddart, F.G.S.; "The Land and Fresh-water Mollusca of the Bristol District," by A. Leipner; "Notes on Bristol Fungi," by C. E. Broome, F.L.S.; "The Rainfall in Bristol during 1874," by G. F. Burder, M.D.

THE numbers of the *Nuovo Giornale Botanico Italiano* for January—July 1875 give evidence of the impulse given to the study of lichens by the recent theory as to their compound and parasitic nature. We have in these numbers two elaborate papers on this subject, based on careful elaborate research, and both well illustrated, but coming to opposite conclusions. A. Borzi adopts the theory of Schwendener and Sachs that the gonidia of lichens have no genetic affinity with the hyphæ, but that the latter are of the nature of ascomycetous fungi parasitic on the former. G. Arcangeli, on the other hand, inclines to the views of Nylander and Tulasne that many algæ belonging to the families Protococcaceæ, Nostocaceæ, and Rivularieæ, are nothing but special forms of the gonidia of lichens; but that the gonidia are true lichen-organs. Prof. Caruel has a short note on the so-called viviparous leaves of *Begonia*, in which he shows that the adventitious buds are in reality metamorphosed hairs. Prof. Beccari has some remarks on the Rafflesiaceæ, supplementary to Dr. Hooker's monograph of the order in De Candolle's "Prodromus." He makes five species of *Rafflesia*—*R. Arnoldii*, *R. Titan*, *R. Patma*, *R. Rochussenii*, and *R. Cumingii*, besides a doubtful one, *R. Horsfieldii*; four of *Hydnora*, viz., *H. africana*, *H. abysinica*, *H. bogociensis*, *H. triceps*; and one *Prosopanche*—*P. Burmeisterii* (*Hydnora americana*). These three numbers contain, in addition, many other useful and important papers.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, July 15.—This number contains an article on the calculation of the arithmetical mean of constant quantities, by Herr Wilczek, and another on the ventilation of the St. Gothard Tunnel.

Bulletin of the Essex Institute, 1874 (Salem, U.S.)—A notable incident in the history of this excellent American Society during 1874, was a visit from the late Rev. C. Kingsley, who delivered a lecture on Westminster Abbey, and in whose honour a reception was afterwards held. The following are the principal scientific papers in the *Bulletin*:—Mr. F. W. Putnam, one of the most active members of the Society, contributes the following:—"Rare Fishes taken in Salem, Beverly, and Marblehead Harbours; "On Black Fish taken in Salem Harbour;" "Notice of a Skull from shell-bed, in Rock Island;" "On Teeth of a large Shark, probably *Carcharis* (*Prionodon*) *lamia*;" "On the Shell-heaps at Eagle Hill;" "Notice of some important Discoveries of the Hayden Exploring Expedition;" "Remarks on a Collection of living specimens of Fishes and Cray pikes from Mammoth Cave." Other papers are:—"Notes on the Mammals of portions of Kansas, Colorado, Wyoming, and Utah," by J. A. Allen; "On the Fertilisation of Flowers," by E. S. Morse; "Notes on examination of four species of Chitons," by W. H. Dall; "On the Change of Colour in Leaves in Autumn," by E. C. Bolles; "On the Theory of Evolution," by E. S. Morse; "Lists of Birds observed from Sacramento to Salt Lake City," by R. Ridgway.

THE *Gazzetta Chimica Italiana*, fasc. v., contains the following papers:—On the oxidation of sulphur, by E. Pollacci. The author describes some interesting experiments he made with flowers of sulphur which he oxidised into sulphuric acid in a number of different ways.—Researches on the products of the action of urea upon asparagine and on aspartic acid, by J. Guareschi.—Preliminary note upon parabanic and oxaluric acids, by the same.—On the vegetation of *Oxalis acetosella*, *Rumex acetosa*, and *acetosella* in a soil which contains no potash, by M. Mercadante.—Account of experiments made with artificial soils and of the anomalies observed in the plants obtained.—On some properties of ferric orthophosphate, by F. Sestini.—Extract of some memoirs read at the Academy of Sciences at Bologna on researches on the poisonous alkaloids, by F. Selmi. These were on some new distinguishing properties and some newly discovered reactions.—There is the usual number of extracts from other journals.

Kongl. Vetenskaps Akademiens Fördhandlingar (Stockholm), Feb. 10.—This part contains the following papers:—On the introduction of elliptic functions into astronomical problems, by H. Gylden.—Hepaticæ Pyranaicæ circa Luchon crescentes, by J. E. Zetterstedt.—Researches on the chemical composition of magnetic iron ore, by G. Lindström.—On the Oniscoideæ of North America, by A. Stuxberg.—On some new Lithiobiæ of the same country, by the same.—On a Lithobius borealis Meinert, found in Sweden, by the same.—Researches on the Syrphus butterfly in its three states of development, by F. Trybom (with plate).—On the Arachnidæ of Gotland and Öland, by G. F. Neuman.—On old ore deposits and their present uses, by O. Gumaelius.

SOCIETIES AND ACADEMIES

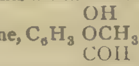
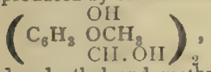
VIENNA

Imperial Academy of Sciences, April 22.—Researches on the epithelium of the stomach, by W. Biedermann.—On the formation of meteorites, by G. Tschermak.—On some measurements of temperature made in the first half of April in the Gmunden and Atter lakes, by Prof. Simony.

April 29.—On the zoological results of the Austro-Hungarian Polar Expedition, by Prof. C. Heller.—Ichthyological researches, by Prof. F. Steindachner.—On the orbit of Planet (138) Tolosa, by Director von Littrow and Dr. L. Gruber.—On the fermentation gases from marsh and water plants, by Prof. J. Boehm.

May 13.—On the genetic classification of the flora of the Cape, by Dr. von Ettingshausen.—On the lichens of Spitzbergen and Novaja Semlja, by Dr. von Hochstetter.—On the orbit of Planet (118) Peitho, by Dr. J. Holetschek.—On the galvanic dilatation of metallic wires, by Prof. Exner.—On the respiration of water plants, and on a fermentation which includes an absorption of hydrogen, by Prof. J. Boehm.—On chalk ammonites, by Dr. Neumayer.

BERLIN

German Chemical Society, July 26.—P. Behrend described a method for preparing chloride of sulphuryl by heating Williamson's oxychloride $SO_2OH\,Cl$ in sealed tubes to 180°. V. Meyer gave an account of an apparatus for determining the solubilities of salts at 100°.—J. Beckmann, by treating benzophenone $C_{13}H_{10}O$ with sulphuric acid, produced a neutral body $C_{13}H_8SO_3$, while sodic benzophenondisulphate, treated with PCl_5, yielded two chlorides, $C_{13}H_8O_5S_2Cl_2$ and $C_{13}H_8O_5S_2Cl_4$.—F. Tiemann and Haarmann published a method for determining the quantity of vanilline in vanilla, by precipitating its solution in ether with bisulphite of soda. Mexican vanilla gave 1·6, best Bourbon vanilla 2·3, Tavavanilla 2·6 p.c. of vanilline. Tavavanilla is less esteemed, on account of other ingredients which affect its fragrance.—F. Tiemann has transformed vanilline,  $C_6H_3\begin{matrix}OH\\OCH_3\\COH\end{matrix}$ into the corresponding acid and alcohol, the latter by the action of hydrogen, produced by sodium-amalgam. This reagent yields also a body  $\left(C_6H_3\begin{matrix}OH\\OCH_3\\CH.OH\end{matrix}\right)_2$, hydrovanilloin. He has likewise introduced ethyl and methyl into the group OH.—C. Raab has treated cuminic aldehyde with hydrocyanic acid and hydrochloric acid, obtaining the corresponding amygdalic acid. By the action of hydrogen he obtained a higher hydrobenzoin.—C. Jackson has obtained tribromonitrobenzol and tribromodinitrobenzol.—The same chemist refuted a pretended reaction of acetanilide. This body does not yield a nitrile and water when heated, as published by Mr. Brackebusch.—A. Steiner has found that NH_3 dissolves fulminate of silver below 40° without alteration. He has also studied the action of sulphocyanide of ammonium on fulminates.—A. W. Hofmann has transformed methyl-xylidine by means of heat into a number of highly carbonated ammonias, chiefly into $C_6(CH_3)_5NH_2$.—A. Oppenheim and L. Jackson described two new derivatives of mercaptan, viz. C_2H_5SHgBr, a white amorphous powder and a combination of iodoform with two molecules of mercuric mercaptide, crystallising in yellow needles. No tribasic thioformate of ethyl could be produced from these compounds.—The following communications were sent by T. Wislicenus:—Under his guidance allyl-aceto-acetic ether has been transformed by F. Zeidler into allylacetic acid and allyl-acetone. L. Ehrlich produced dibenzil-acetic ether and benzyl-oxybutyric ether. H. Rohrbeck, by treating methylacetoacetic ether with hydrogen, produced methyloxybutyric acid, which, when heated, yields methyl-crotonic acid. E. Waldschmidt has obtained the corresponding ethyl-compounds. M. Conrad, by treating aceto-acetic ether with chlorine, obtained substitution compounds and dichloracetone. F. Hermann has studied the action of sodium of succinic ether. The next meeting will take place on the 11th of October.

PARIS

Academy of Sciences, Aug. 9.—M. Frémy in the chair.—The following papers were read:—Application of the method of correspondence to questions of the magnitude of segments on tangents of curves, by M. Chasles.—Remarks on the note of M. Nicolaides read at the last meeting, by M. O. Bonnet.—A note by M. Thenard, on some blue substance found in clay.—Three reports by M. Janssen concerning the expedition sent to Japan to observe the transit of Venus across the sun's disc.—Calorimetric researches on the siliciurets of iron and manganese, by MM. Troost and T. Hautefeuille.—Researches on niobates and tantalates, by M. A. Joly.—Facts relating to the investigation of polyatomic alcohols, and their application to a new method for obtaining crystallised formic acid, by M. Lorin.—MM. G. Baker, Decoster de Wilder, Garcia de los Rios, Imbert, and Bordet then made some communications regarding Phylloxera.—M. Reech then presented a new edition of his memoir on surfaces which can be superposed on themselves, each in all its parts.—The Minister of Public Instruction sent the translation of an article, published by the Ministerial journal of Copenhagen, and treating of the volcanic phenomena which in the course of last winter have occurred in Iceland.—Discovery of Planet (148), made at Paris Observatory, by M. Prosper Henry, on the night of Aug. 7 last.—Observations of Planet (148) at the equatorial, by M. M. Henry.—Ephemerides of Planet (103), Hera, for the opposition of 1876, by M. Lereau.—Experiments with gas under high pressure, by M. Andrews.—On a property of an electrified surface of water, by M. G. Lippmann.—A note on sulphocarbonates, by M. A. Gélis.—On the preparation of crystallised monobromide of camphor, by M. Clin.—On some points in the physiological and therapeutic action of monobromide of camphor, by M. Bourneville.—On Marsh's apparatus and on its application for the determination of arsenic contained in organic matter, by M. Arm. Gautier.—On the larva forms of Bryozoa, by M. Barrois.—Observations by M. C. Dareste, on a recent communication of M. Joly.—On the temperature of the Mediterranean Sea along the coasts of Algeria, by MM. Ch. Grad and P. Hagenmüller.—On a waterspout observed at Morges on Aug. 4 last, by M. A. Foret.—On the identity in the mode of formation of the earth and the sun, by M. Gazan.

BOOKS AND PAMPHLETS RECEIVED

AMERICAN.—Report upon the Reconnaissance of the North-Western Wyoming and Yellowstone National Park: Wm. A. Jones (Washington).—The Geological Story briefly told: James D. Dana, LL.D. (Trubner and Co.)—Proceedings of the American Academy of Arts and Sciences, N.S. Vol. ii.—Third Report of the Zoological Society of Philadelphia.—Chronological Observations on Introduced Animals and Plants: Chas. Pickering, M.D. (Boston: Little, Brown and Co.)—Report of the U.S. Geological Survey of the Territories. Vol. vi.: F. V. Hayden (Washington).—How to use the Microscope: John Phin (Industrial Publishing Company, N.Y.)—Proceedings of the Academy of Natural Sciences of Philadelphia. Part I.

COLONIAL.—Report of Neilgherry Loranthageous Parasitical Plants destructive to Exotic Forest and Fruit Trees: George Bidie, M.B. (Government Press, Madras).

FOREIGN.—Bulletin de l'Académie Impériale des Sciences de St Petersbourg. Tome xix. Feuilles 22-37, Tome xx. Feuilles 1-21.—Der Ursprung der Wirbelthiere und das Princip des Functionswechsels: von Anton Dohrn (Leipzig, Engelmann).—Die Geologie und Ihre Anwendung auf die Kenntniss der Bodenbeschaffenheit der Oesterr.-Ungar. Monarchie: von Franz Ritter von Hauer (Wein, A. Hölder).

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Sir Charles Lyell

Engraved by C. H. Jeens from a Photograph

THURSDAY, AUGUST 26, 1875

SCIENTIFIC WORTHIES

VI.—SIR CHARLES LYELL, BORN NOV. 14, 1797; DIED FEB. 22, 1875.

SINCE its last meeting the British Association has lost one of its oldest members and most illustrious presidents. There are some men the story of whose mental development and progress in scientific research may be taken as almost embracing the history, during their lives, of the science to which they devoted themselves. Of such men we have not many brighter examples than that of Sir Charles Lyell. For somewhere about half a century he continued in the van of English geologists, and so identified himself with them and their pursuits as to be justly taken as the leader of geological speculation in this country. The time has probably not yet come when his true position in the roll of scientific worthies can be definitely fixed. The revolutions of thought which have taken place within the last fifteen years, and in which, let it never be forgotten, Lyell himself bore a conspicuous and indeed heroic part, have so shaken old beliefs which once seemed securely based on the most cautious induction from well-ascertained facts, that even they who have most closely watched the march of events will probably shrink most from the attempt to estimate the full and true value of the work of his long and honoured life. It is not, then, with any aim at such an estimate, but rather to recall some of the leading characters of his work, that this brief *in memoriam* is now written.

Perhaps the best idea of the solid services rendered by Lyell to Geology is obtained by looking back at the condition of the science when he first began to study it, and by contrasting that state with the same subject as treated by him in the early editions of his "Principles." To men who had been compelled to gain their general view of geology from such works as Daubuisson's "Traité," the appearance of Lyell's volumes must have been of the nature of a new revelation. From vague statements about early convulsions and a former higher intensity of all terrestrial energy, they were led back with rare sagacity and eloquence to the living, moving world around them, and taught to find there in actual progress now the analogues of all that they could discover to have been effected in the geological past. The key-note which Lyell struck at the very outset and which sounded through all the work of his career was, that in geology we must explain the past by the present;—that the forces now in operation are quite powerful enough to produce changes as stupendous as any which have taken place in former times, provided only that they get time enough for their task.

These views were not promulgated for the first time by the author of the "Principles of Geology." In cruder form they had been earnestly urged by Hutton, and eloquently illustrated and extended by Playfair. But after much turmoil and conflict of opinion, they had very generally been allowed to sink out of sight. On the Continent, indeed, they had never excited much attention, and were for the most part ignored as mere vague speculation. Even in this country they had only been partially adopted even by those who professed to belong to the Huttonian school. So that it was in one sense as a new doctrine that they were taken up by Lyell and enforced with a wealth of illustration and cogency of argument which rapidly gained acceptance for them in Britain, and eventually led to their development in every country where the science is cultivated.

In one important respect, however, the doctrines taught by Sir Charles Lyell differed from those of his predecessors. Hutton and Playfair knew almost nothing of fossil organic remains. They were necessarily ignorant of the light which these can cast upon the past history of the globe. They had but a dim perception of the long and varied succession of the stratified formations embraced by their own terms Primary and Secondary. After their days, however, the labours of William Smith among the Secondary rocks of England showed that the strata of the earth's crust could be identified and classified in their order of age by means of the fossil animal remains contained in them. Then came the brilliant discoveries of Cuvier in the Tertiary basin of Paris and the rise of the science of Palæontology. It was now seen that the discussion of theoretical questions in cosmogony and the collection and description of minerals and rocks did not comprise by any means the whole of geology. Year by year it became more evident that, besides all its records of physical revolutions, the crust of the earth contained materials for a history of organic nature from early geological times down to the present day. In this transition state of the science there was manifestly needed some leisured thinker who could devote a calm judgment and a facile pen to the task of codifying the scattered observations which had accumulated to so vast an extent, and of evolving from them the general principles which they seemed to establish, and which, when clearly announced, could not fail greatly to assist and stimulate the future progress of geology. Such was the task which Lyell set before himself, somewhere about half a century ago, and in fulfilment of which his "Principles" appeared.

In that great work the twofold aspect of geology—its inorganic or physical side and its organic or biological side—was recognised and admirably illustrated. It was in the treatment of the first of these that the earlier editions of the "Principles" stood specially distinguished from previous writings. The leading idea of their author was, as already remarked, not original on his part. Besides the writings of Hutton, Playfair, and their followers, the appeal to history and to everyday experience as to the true nature and results of the present working of the various terrestrial agents had already been made in considerable detail by Von Hoff in Germany. Nevertheless, until the advent of Lyell's work the views he adopted had got no real hold of men's minds. It was his enforcement of them which secured for them first a careful examination, and ultimately a very general acceptance. In explaining former revolutions of the globe, geologists had usually proceeded on the tacit assumption that no serious argument was required to prove these revolutions to have been far more violent in their progress and stupendous in their results than could possibly have been achieved by any such energy as is still left upon the earth. Accordingly, on the whole they were disposed to neglect the consideration of proofs of modern changes on the earth's surface, looking upon these as mere faded relics of the power with which geological changes were formerly effected. It is impossible to exaggerate the service which Lyell did to the cause of truth by boldly striking at the very root of this fundamental postulate of his contemporaries, and showing, by a wide induction of facts from all parts of the world, how really potent were the present apparently quiet and ineffective processes of change. With most uncompromising logic he drove it home to the hearts and consciences even of sturdy convulsionists, that they had all along been reasoning in a circle, and that the evidence on which they so confidently relied demanded and could receive another and very different interpretation.

It was a great matter to shake the old convulsionist faith and bring men back to the study of the actual operations of nature at the present time. Greatly more difficult, however, was the task to build up another creed and gain adherents to it. Yet this was accomplished by Lyell with an abundant measure of success. He came to be recognised as the great reformer in geology, the high priest of the Uniformitarian school, the leader under whom in this country the younger men eagerly ranged themselves. Through the influence of his writings a fresh and healthy spirit of scrutiny and observation spread through the study of geology. And as edition after edition of his work appeared, each more richly laden than its predecessors with stores of facts gathered from all branches of science in illustration of his subject, men were led to realise how narrow had been the old conception which limited the scope of geology merely to the study of minerals and rocks and the elaboration of cosmological theories. Every department of nature which could throw light upon the terrestrial changes now in progress and thereby elucidate the history of those which had taken place in former times was made to yield its quota of evidence. Hence it came about that the study of geology received in Britain a breadth of treatment which had never before been given to it either in this or any other country. The main share in this reform must be assigned to the genius and perseverance of Lyell.

But in science as in politics no reform can provide for all the requirements of the future. In proportion to the zeal with which the new creed is adopted and proclaimed, there may be and often is an inability to recognise such measure of truth as may have underlain the older faiths, as well as to realise the weak points in that which is set up in their place. The essential doctrine of the Uniformitarian School was in reality based on an assumption not less than those of the older dogmas. It was an assumption indeed which did not rest on mere crude speculation, but on a wide range of observation and induction, and it claimed to be borne out by all that was known regarding the present economy of nature. It professed to be in accordance with the logical method of reasoning from the known to the unknown. Nevertheless, in the course of years the Uniformitarians gradually lost sight of the fact that the present order of nature on which they asserted that their system rested could not, without a manifest and perhaps in the end an unwarrantable assumption, be taken as the standard whereby the order of nature in all past geological time was to be gauged. The information gained by human observation during the few centuries in which man had taken intelligent interest in the world around him was valuable as a basis for hypothesis, but only for hypothesis which should be cast aside so soon as the requirements of a wider knowledge might demand. The Uniformitarians, however, gradually slid into the belief that though perchance they had not absolutely proved terrestrial energy never to have been more powerful than at present, yet they had shown that the supposed proofs of former greater intensity were illusory, and hence that their own doctrines should be accepted as by far the most reasonable, and indeed as the only safe guide in the interpretation of the past history of the earth. Most admirable has been the work done by the Uniformitarians, and deep are the obligations under which Geology must ever lie to them. But in the onward march of mental progress it is now their turn to have their confident belief called in question. Another School is rising among them, accepting from them by far the larger part of their doctrines, but in their own spirit of bold inquiry and with their own zeal in the cause of truth, seeking to enlarge the basis on which our ideas of the full sweep of nature's operations are to rest.

The other, or biological side of geological science, owes much of its development to the skill with which it was handled in the successive editions of the "Principles." Though not himself in the strict sense either a zoologist or botanist, Sir Charles Lyell throughout his life kept himself abreast of the progress of the biological sciences and on terms of intimate relationship with those by whom that progress was sustained in this country and abroad. He was in the true meaning of the word a naturalist. He had in his day few equals in the grasp which he could take of natural history subjects in their geological aspects. The geographical distribution of plants and animals was one of those subjects which received more and more ample treatment from him as he advanced in years. The succession of living forms in time was another theme which gave him full scope for accurate and eloquent description. In fact, the breadth of his conception of what geology ought to be was not less conspicuously marked in this than in the physical department of the science. He enlisted in his service every branch of biological inquiry which could elucidate the former history of the earth and its inhabitants. And not merely the published information on these questions, but many of the floating ideas of discoverers found exposition and illustration in his pages.

One of the biological subjects to which he devoted much time and thought was one which in recent years has received renewed attention and provoked increased discussion—the origin of the successive species of plants and animals which have appeared upon the earth. During the greater part of his career Sir Charles Lyell distinguished himself as one of the most uncompromising opponents of development theories such as those of Lamarck and the author of the "Vestiges of Creation." Such views ran counter to his uniformitarian faith, and he brought against them a large armoury of geological weapons. The non-appearance of higher types of life among the older formations he contended to be no evidence in favour of development. It was simply negative evidence, and could at any moment be destroyed by the discovery of one positive fact in the shape of a bone, tooth, or other fragment. No one could make better use than he of such fortunate finds as that of Dr. Dawson among the ancient carboniferous forests of Nova Scotia, when from the heart of a fossil tree quite a little museum of land-snails and lizard-like forms was obtained; or those which revealed such remarkable assemblages of little marsupial and other mammalian forms from thin and local deposits like the Stonesfield slate and Purbeck beds. But negative evidence, when multiplied enormously by observers all over the world without any important contradiction, becomes too overwhelming to be explained away. Though convinced of the untenableness of the views of development which he opposed, Sir Charles may have had his misgivings at times that the yearly increasing and enormous body of negative evidence in favour of the non-existence of higher types of life in the earlier geological periods could not be due to the mere accident of non-preservation or non-discovery. At all events, when Mr. Darwin's views as to the origin of species were made known, Sir Charles, recognising in them the same basis of wide observation and the same methods of logical analysis for which he had himself all along contended in geology, at once and zealously accepted them—a bold and candid act, seeing that it involved the surrender of opinions which he had been defending all his life. In no respect did he show his remarkable receptive power and the freshness with which he had preserved his faculty of seeing the geological bearings of new truths more conspicuously than in the courage and skill with which he espoused Mr. Darwin's hypothesis and proceeded at once to link it with the general philosophy of geology.

Of his work among the Tertiary formations, with the nomenclature by which, through that work, they are now universally known, his observations on the rise of land in Sweden, his researches into the structure of volcanic cones, and other original contributions, over and above the solid additions to science supplied by the numerous editions of his popular works, it is not needful to make mention here. Enough is gained if at this time these few lines recall some of the services to which Sir Charles Lyell devoted a long, honourable, and illustrious life, which have graven his name in large letters on the front of the temple of science, and in memory of which that name will long be remembered with gratitude and enthusiasm as a watchword among the students of geology.

ARCHIBALD GEIKIE

WATTS' DICTIONARY OF CHEMISTRY

A Dictionary of Chemistry and the Allied Branches of other Sciences. By Henry Watts, B.A., F.R.S., &c. Second Supplement. (Longmans, Green, and Co., 1875.)

THE appearance of the second supplement to Watts' "Dictionary of Chemistry" is an event in the history of chemical literature which will certainly be welcomed by all English chemists. Although it may be said with truth that no great generalisations have been made of late years in chemistry, the science is nevertheless advancing with gigantic strides so far as the accumulation of facts is concerned. Perhaps no science possesses such an extensive journalistic literature as Chemistry; month after month the journals of the Chemical Societies of London and Berlin, the *Gazzetta Chimica Italiana*, the *Annalen der Chemie*, *Poggendorff's Annalen*, the *Annales de Chemie*, the proceedings and transactions of the various learned Societies, as well as numerous smaller chemical publications, all contribute to the vast store of facts already recorded. It is not to be wondered, then, that during the nine years which Mr. Watts devoted to the compilation of his dictionary, the science should have continued its growth at such a pace that the author found it necessary to promise on the completion of the work (Preface to Vol. V., 1869) a supplementary volume bringing the record of discovery down to the existing state of knowledge. The first supplement accordingly appeared in 1872, bringing the history of the science down to the end of 1869. The volume now before us carries the record of discovery down to the end of 1872, and includes some of the more important discoveries made in 1873 and 1874.

From the contents of the present supplement we cannot select more than a few of the longer articles for notice here.

Turning first to the article on benzene, one cannot fail to be struck with the rapid growth of our knowledge of this body and its derivatives within the last few years. The list of haloid, nitro-haloid, &c., derivatives has been considerably increased since the publication of the last supplement by the discovery of new isomeric modifications of these bodies—modifications the discovery of which cannot but be regarded as signal triumphs to chemical theory when we call to mind the fact that the impetus given to the study of benzene, the fundamental hydrocarbon of the aromatic series, arose from the theoretical speculations of Kekulé and his school.

The subject of capillarity is treated of with considerable detail in an article some nine pages in length. The development of this subject is due to the researches of Quincke, Karmarsch, Buliginsky, Valson, and others. The article on chemical action contributes much of importance to the subject: we may particularly mention Mill's researches on the co-efficient of chemical activity, the numerous researches by Berthelot, in conjunction with Jungfleisch on the division of a body between two solvents, and with St. Martin on the state of salts in solution; likewise Favre and Valson's experiments on crystalline dissociation. Passing on to the cinchona alkaloids, we find that three new substances—quinamine, paricine, and paycine—have been added to the list by Hesse. The "constitution" of these cinchona alkaloids is among the problems still awaiting solution at the hands of chemists—may it not be hoped that the synthesis of quinine will one day—as that of alizarine—be a chemical possibility? In electricity, the chief additions to our knowledge are Becquerel's experiments on electro-capillary action, Quincke's theory of electrolysis, and Guthrie's experiments on the relationship between heat and electricity. The mechanical theory of gases has developed into a separate article of considerable importance in our eyes.

Avogadro's law—the safest foundation on which to build modern chemistry—is directly deducible from the fundamental equation of Clausius :—

$$p = \frac{nmc^2}{3v}$$

so that not only does our modern system of chemistry rest on a thermodynamical basis, but the future of chemical generalisation—judging from the tendency of recent research—lies in this direction also. The subject of heat has received great additions ; the laborious determinations of the specific heats of solutions by Thomsen furnish material for three pages. The "heat of chemical action" has developed enormously through the labours of Thomsen, Hautefeuille, Ditte, and Marignac. Berthelot has also contributed largely to the subject by his thermochemical researches. In industrial chemistry we find much valuable matter added to the metallurgy of iron, the article bringing us down to the invention of Siemens' rotative furnace for obtaining malleable iron and steel directly from the ore. In light, perhaps the most substantial additions to science are to be found in Gladstone's calculations of refraction equivalents, Christiansen, Kundt, Soret, and Sellmeier's researches on anomalous dispersion, and Rammelsberg's researches on the relations between circular polarisation and crystalline form. The articles on the chemical action of light and spectral analysis, contributed by Prof. Roscoe, are excellent *résumés* of the present state of knowledge in these branches of chemical physics. In the latter subject great progress has been made through the labours of Lockyer (discovery of long and short lines in metallic spectra), Roscoe and Schuster (new absorption spectra of potassium and sodium), and Lockyer and Roberts (new absorption spectra of various metals—suggestions for a possible quantitative spectrum analysis).

Prof. G. C. Foster contributes the article on magnetism, and Prof. Armstrong that on the phenols. Most of the articles on physiological chemistry are from the pen of Dr. H. Newell Martin ; and Mr. R. Warington furnishes some valuable articles on subjects relating to agricultural chemistry.

The second supplement exhibits all the care and painstaking conscientiousness of the former volumes, and will be found of invaluable service both to teachers and workers. The names of Mr. Watts and his coadjutors sufficiently guarantee the reliability of the work ; the "Dictionary" has in fact justly taken its rank as one of the standard works of reference in this country.

Seeing that the results of chemical research are flowing into the scientific world in a continuous and ever increasing polyglot stream, both professors and students of the science are indebted to Mr. Watts for the laborious task which he has accomplished for their benefit.

For our own part we look with eager interest upon the continuous encroachment of physics upon chemistry, and venture to hope that the time may not be far distant when generalisation may lead to natural classifications, causing the handbooks and dictionaries of the future to be for the same quantity of information somewhat less bulky in volume.

R. MELDOLA

HIS ON MORPHOLOGICAL CAUSATION

Unsere Körperform und das physiologische Problem ihrer Enstehung. Briefe an einen befreundeten Naturforscher, von Wilhelm His. (Leipzig : Vogel, 1875. London : Williams and Norgate.)

THIS is not, as might perhaps (from its title and from a hasty glance at its contents) be imagined, a popular exposition of the main facts of Embryology as ordinarily understood. Prof. His has been led by his researches to adopt peculiar views concerning the causation of animal forms. These he has explained at some considerable length in his great work on the "Development of the Chick," and elsewhere, but they have not met with very general acceptance ; and the little work we are noticing has for its object a popular and somewhat fuller explanation of these views, and a defence of them against various critics. Among these critics the most conspicuous is Haeckel, whose, to say the least, severe remarks on the author have occasioned a very spirited retaliation. In fact the work, small as it is and popular as it is intended to be, is very largely controversial ; and it has always appeared to us a sign of weakness when a scientific combatant brings his quarrel before a general public.

Without going at all fully into the views of our author, we may say that he strives to explain many of the facts of animal morphology by the agency of mechanical causes acting directly on the growing germ or embryo. Thus for him the large eyes of the young chick are the direct cause, by compression, of the sharp beak of the bird ; and more generally the unequal tensions produced by unequal growth in the initial flat blastoderm determine, through the agency of certain folds, the form of the animal which springs from it.

As might be expected, many pages of the book are devoted to an attempt at reconciling these views with a modified theory of descent. Speaking broadly, the views of the author may be said to differ from those generally entertained, chiefly on the question whether it is the horse which pulls the cart or the cart the horse, or perhaps rather on the point which is the cart and which the horse. We very much fear that Prof. His's horse is really the cart.

M. F.

OUR BOOK SHELF

Bristol and its Environs, Historical and Descriptive. Published under the sanction of the Local Executive Committee of the British Association. (London : Houlston and Sons. Bristol : Wright and Co., 1875.)

IT was some time ago announced that a Guide to Bristol was being prepared for visitors to the British Association Meeting. This is now published, and appears as an 8vo volume of 475 pages bound in cloth. In many respects the local committee have made great exertions to make the visit in every way a pleasant one, and this has been pretty well known, but so voluminous a guide as this is certainly a surprise. It is well got up, and is illustrated both with views of the buildings in the town and with diagrams illustrative of the geology of the district. Many pens have been employed in its preparation. "The contributions," the Introduction states, "are honorary—the several authors have written with pure love of their subject, and for the sake of doing homage to the occasion that has called forth the volume."

The first two sections, both of them on Ancient Bristol, are by Mr. J. Taylor, of the Bristol Library. Section 3, on Modern Bristol, is by Mr. J. F. Nicholls, of the City Library. The fourth section, on Local Government and Taxation, is by Mr. H. Naish: and then follows a section on Educational Organisations, to which there are several contributors. Mr. D. Davies, the medical officer of health, has supplied the section on Sanitary Condition and Arrangements, after which comes Section 7, on Physical Geography and Geology. This occupies sixty-four pages, and would perhaps have been of more practical use if printed as a separate pamphlet that could be conveniently carried in the pocket. Mr. Tawney has written the Introduction; the Silurian, the Carboniferous, and Millstone Grit is by Mr. Stoddart; the part on the Coal Measures and "New Red Period" is written by Mr. Tawney; that on the Rhætic and Liassic by Mr. Ralph Tate, and the concluding part on the Inferior Oolite is again by Mr. Tawney.

Bristol is better off for geological maps than any other part of the country, for not only are there the sheets of the Geological Survey, but there is Mr. Sanders' splendid map of six inches to the mile, which includes the whole of the Bristol coal-field.

It is a pity there was not a sketch map introduced in the guide, with just the names given of the places referred to and an indication of the spots where the sections are taken from. As it is, strangers to the district will experience some difficulty in following the text, as many of the names are not on the published maps. With regard to the sections, too, there is no indication of the direction in which they are taken, nor of the scale to which they are drawn. One of the most useful features of the geological portion is that which gives the localities where the sections of the strata can be seen; and, as the district within a short distance contains from the Silurian up to the Oolites, omitting the Permian, ~~is of interest. There~~ are many references to the more important papers that have been printed, and in cases of difference of opinion the writer has added his own views. The much vexed question of the age of the "dolomitic," "triassic," "magnesian," or "reptilian" conglomerate, is duly referred to.

The notes on anthropology have reference to the tumuli and chambered barrows, and to the present condition of Bristolians. "A certain amount of physical degeneration has taken place among the native Bristolians, as among the natives of other British cities; 300 of them yielded to me an average stature and weight of 5 feet 5·8 inches and 132½ lbs., after deductions made for shoes and clothing. The average height of men in the surrounding counties may fairly be put at half an inch more."

The book has one serious defect, for which the compiler and not the authors are responsible; there is no index.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

"Climate and Time"

THE review of "Climate and Time" in NATURE, vol. xii. p. 121, contains some remarks in reference to my tables of the eccentricity of the earth's orbit, to which, in justice to myself, I must refer, the more so as they relate to points which comparatively few of your readers have it within their power to determine whether or not the reviewer was justified in making the remarks in question.

"We have repeated," says the reviewer, "the calculations for two of the most remarkable dates, viz., 850,000 and 900,000 years ago respectively, and find that at the former date the eccentricity was ·0697 instead of ·0747, and at the latter date was ·0278 instead of ·0102 as expressed in the table."

What proof does the reviewer give that his results are correct and mine incorrect? The following is the reason he assigns:—"To satisfy ourselves," he says, "that the mistakes are Mr. Croll's and not ours, we have recalculated also one of Mr. Stone's and one of M. Leverrier's, and in both instances have exactly verified them." This can hardly be accepted as sufficient evidence, for I had myself recalculated one of Mr. Stone's and no fewer than five of M. Leverrier's, "and exactly verified them."

I suspect that the reviewer has made his calculations somewhat too hastily; for if he will go over them a little more carefully, he will, I have no doubt, find that after all my results are perfectly correct, excepting only a trifling typographical error, to which I shall presently refer.

The value for 900,000 years ago ought to be ·0109 instead of ·0102, as stated in the table. This mistake arose out of the curious circumstance of a small speck of ink having been dropped on the tail of the 9, which led to its having been substituted for a 2, ten years ago when the tables were first published—a fact of which I was not aware till a week or two ago, when looking over the manuscripts of my original calculations, all of which I have preserved. Since my calculations were called in question by your reviewer, I have had them examined by three experienced mathematicians, and the conclusion at which each of them has arrived is that they are perfectly correct.

The reviewer continues:—"The fact that the eccentricity was large when he represents it so, and small when he makes it small, seems to indicate that some approximating progress [process?] has been followed, and that possibly his diagram may give a *rough* idea of the changes of eccentricity for past time."

I can assure the reviewer that nothing could be further from the truth than this assumption. I have computed the eccentricity and longitude of the perihelion for no fewer than 129 separate periods, and in every case Leverrier's formulæ have been rigidly followed, and I have every reason to believe that the diagram gives not a *rough* but an *accurate* idea of the changes of eccentricity. The values given in the tables will, I trust, be found to be perfectly accurate up to at least the fourth place of decimals, which is as far as these formulæ can be relied upon to ~~yield correct~~ results.

The following are the results which, considering the trouble that has been given to their verification, I think will stand the most severe scrutiny:—

Period 850,000 years ago.	Period 900,000 years ago.
$h^2 = {\cdot}00413927$	$h^2 = {\cdot}000059858$
$l^2 = {\cdot}00144124$	$l^2 = {\cdot}000059812$
$h^2 + l^2 = {\cdot}00558051$	$h^2 + l^2 = {\cdot}000119670$
$\sqrt{h^2 + l^2} = {\cdot}0747 =$ Eccentricity	$\sqrt{h^2 + l^2} = {\cdot}010939 =$ Eccentricity

Edinburgh, August 10

JAMES CROLL

A Lunar Rainbow, or an Intra-lunar convergence of Streams of slightly illuminated Cosmic Dust?

ABOUT 8.30 P.M. yesterday a large zone of the sky, from the horizon at W.N.W. to the horizon at E. by S., was illuminated in a very remarkable manner, and this illumination lasted about three-quarters of an hour, when it gradually died out.

During all this time the sky was very clear and cloudless, thereby forming a dark back-ground, on which the phenomenon, whether lunar rainbow, or many rainbows, or intra-lunar converging streams of cosmic matter, was splendidly projected.

This exhibition consisted of one grand central feather springing out of the horizon at W.N.W. and crossing this meridian at about 20° north of the zenith. The width of this stream, with little variation throughout its length, was 7° or 8°. Its light was that of a *very bright* white cloud, its edges most beautifully defined; its form that of a very elongated feather, but without any shaft. On either side of this main feather was a system of seven or eight minor and fainter streams, threads, or beams of light, all more or less extending from the western to the eastern horizon, subtending a chord common to themselves and to the main stream of light, and converging towards the axis of the central stream so as apparently to intersect it at a point about 30° or 40° below the western horizon, at which the whole system subtended an azimuth of about 20°; and near the zenith, where its transverse section was a maximum, that section subtended an angle of about 40°. At this time the moon was about 15° east of the meridian, and her declination about 9° S. Both systems of the minor streams of light on the sides of the main stream appeared to have a slight libratory motion, or to slew upwards towards the main stream, and therefore perpendicularly to their length.

Nothing could suggest to the mind more strongly the idea of converging streams of infinitely minute particles of matter passing through space at a distance from the earth less than that of the moon, and at which the earth's aërial envelope may still have a density sufficient, by its resistance, to give to cosmic dust passing through it with planetary velocity that slight illumination which it possessed.

The rapid development of the luminosity of these streams on this occasion is evidenced by the fact that they were observed at the time of leaving church, namely, 8 P.M. to 8.20 P.M., by none of the several congregations of this town and Perth, but were observed by many persons from a quarter to half an hour after that time, so far as I have yet been able to ascertain by a rather extensive inquiry. On coming out of church I myself certainly looked round the whole visible horizon and the higher portion of the heavens, and I made to a companion some observations on the clearness of the stars and dark blue colour of the sky; but about twenty minutes after my exit from church these streams of light had attained their maximum of illumination.

Their apparent figure was that of a nearly circular (slightly flattened) arc of an amplitude of 15° or 20°, as viewed from the middle point of its chord. Both the brightness and the convergence of the streams towards the western horizon were more marked than those towards the eastern horizon.

Fremantle, West Australia, May 17 J. W. N. LEFROY

PS.—Since writing the above, in the Supplement of the *South Australian Register* of Thursday, May 20, I have found the following paragraph:—

"A beautiful lunar rainbow was visible in the western heavens on the evening of Sunday, the 16th inst., a few minutes after 8 o'clock. For a short time the arch was nearly perfect, but for upwards of fifteen minutes the limbs were very bright. The southern limb also appeared visible for some time after the upper portion of the arch had faded away."

Now, allowing for the difference of local time between Fremantle and Adelaide, I think it fairly assumable that this paragraph must refer to the same phenomenon which I have attempted to describe as above; and, if so, it clearly shows that it was *not* a lunar rainbow. I can find no allusion to it in any Melbourne paper yet received here, and which reach to the 19th inst. There the sky may that evening have been cloudy, and thus have rendered it invisible. All intelligent persons here who observed it, and with whom I have had opportunity of conversing since the 16th inst. to this day, concur in my impression that minor lateral streams or feathers of light on the north side of the main stream intervened between the earth and the moon, and one or more of them in its slow librations swept the surface of the moon and sensibly obscured its light.—J. W. N. L.

May 31

"Instinct" and "Reason"

A FEW facts came under my observation during the spring of this year that strikingly illustrate this subject. A pair of blackbirds built a nest on the top of my garden wall, which is thickly covered with ivy and within three yards of the drawing-room window. When the young birds were about three parts fledged one of them by some mishap left the nest and fell into the flower garden. My cat (seven years old, and which has killed scores of small birds) immediately found it, and at the same time a kitten (about three months old, but not belonging to the cat) began to pay rather rude attentions to the young blackbird, and would have used it as kittens are wont, but the old cat would not suffer her to touch it. The cause of this was the old cock blackbird, being aware of the peril of its young, made a great noise and kept flying here and there around the scene of action, crying and scolding with might and main. It then became evident to me that the cat had two or three objects in view, and a purpose to gain. Firstly, not to allow the kitten to touch, or kill, or make off with the young bird. Secondly, to use the young bird as a decoy to entrap the old one. Thirdly, to make the young bird cry sufficiently from fear or pain to induce the parent's affection to overcome its discretion.

During the manœuvres old Tom repeatedly made unsuccessful springs to catch the cock-bird, alternately running to give the kitten a lesson of patience, or self-denial, or impose a fear of punishment. The young bird repeatedly hopped out of sight amongst the flowers and stinted its cries; then anon the cat touched it again and made it flutter about and cry again, which from time to time brought the old bird down with cries of terror, or wrath, or a blending of both emotions, and almost into the very mouth of the cat. Two or three times I thought old Tom was successful, but no, he missed his object most surprisingly. It became evident to me that the cat was using the young bird as a decoy to catch the old one. After I had watched some ten or fifteen minutes, it became too painful for me to witness, so I caught the young bird and put it again into its nest, which was about ten feet from the ground.

In less than an hour the young bird was again on the ground, the cat, kitten, and parent bird performing the same drama, with this difference in the acting: the cat lay down, rolled about, or sat at a convenient distance from the young bird, yet with eyes alert, though half shut, and otherwise giving an assurance that he did not intend to make another bound without succeeding to catch his prey. He was, however, disappointed, and made four without achieving his purpose. At this juncture the mother-bird came on the stage with cries of distress, but kept aloof on the branches of a tall cherry-tree that rises above the wall; and if her boldness were less than the cock-bird's, her discretion was greater, for she kept far aloft. Once it seemed to me that the cock-bird actually struck the back or head of the cat with his wing and mandible. This scene continued about seven or ten minutes, when I again caught the young bird and threw it over the wall, and the exhibition of animal thought, emotion, and passion ceased.

Here were manifested phenomena of a more remarkable kind than those seen in the cases cited by the Duke of Argyll in the *Contemporary Review* for July, in an article to illustrate "Animal Instinct in relation to the Mind of Man," for the cat showed an amount of reasoning which he probably never before exercised, because never before placed in the same circumstances. That he had used young sparrows, of which he must have caught scores, as decoys to catch the old ones is possible, but I am perfectly sure that no kitten ever was in the garden during his reign as "monarch of all he surveyed" in the shape of birds. Hence his authority over the kitten, which was full of life and eagerness to appropriate the young bird, the killing of which would have defeated the purpose of the cat in using the young bird as a decoy to catch the old one, was indeed remarkable, and disclosed a combination of mental forces of self-conscious reason of no trifling order, and, as it appears to me, conclusive that the difference—and only difference—between instinct and reason is one of degree. JAMES HUTCHINGS

Banbury, Aug. 16

OUR ASTRONOMICAL COLUMN

DOUBLE STARS.—Dr. Doberck, of Markree Observatory, has published a first approximation to the elements of ζ Aquarii, on measures between 1781 and 1870, in which long interval, however, the angle of position has only changed 45°—a case where very great latitude must be allowed to any orbit that may be deduced. Dr. Doberck fixes the peri-astron passage to 1924·15, and assigns a period of revolution of upwards of 1,500 years. The latest measures we have met with are those of Nobile, taken at the Observatory of Naples in November 1873, giving the angle 335°·5, or 3°·4 greater than that calculated.—There appears now a probability that the smaller component of 44 Bootis has passed its greatest apparent distance from the primary several years since: if good measures of distance have been made this year, they ought to be sufficient to enable us to pronounce definitely upon this point. That this star forms a true binary there can be no doubt, though it is Sir W. Herschel's measures in 1781 and 1802 alone, that afford conclusive evidence of the physical connection of the components. Thus we might represent the measures between Struve's earliest in 1819 and the present time by the formulæ

$$\triangle \alpha = -\,3''{\cdot}4233 - [8{\cdot}8968]\,(t - 1830{\cdot}88)$$
$$\triangle \delta = -\,1\,{\cdot}6979 - [8{\cdot}3115]\,(t - 1830{\cdot}88)$$

But if we calculate from the same formulæ for Sir W. Herschel's epochs we find,

1781·62	Position	156°·1	Distance	0″·75
1802·25	,,	214 ·8	,,	1 ·35

These are greatly at variance with the positions observed, which show that the companion was then in the following semi-circle, and by the estimates of distance had approached the primary between 1781 and 1802. Barclay's epoch 1871·4 assigns a distance less by 0″·35 than was observed at Leyton in 1866, which is confirmed by Dembowski's measures about the same time. There is in the case of this star a very unusual discordance between the distances of Struve and Dawes, which attains a maximum, 0″·45, about 1836-5; in deducing the above formulæ Struve's measures were employed. The rate of increase in the distance has been diminishing, until by Dembowski's measures, 1863-68, it was less than 0″·01 annually; the orbit is evidently inclined only a few degrees to the line of sight, so that the companion made a very close approach between 1802 and 1819.—If the angles of position, in the case of Σ 1819 between 1828 and 1870 are projected, it will appear that the velocity has been diminishing from about 2°·1 in 1840, to 0°·85 at the end of the period, which with the accompanying increase of distance confirms Struve's judgment as to orbital motion; there is already a diminution of angle of nearly 70° since the first Dorpat measures.—It may be hoped that Σ 2107 has not been forgotten this year.

M. LEVERRIER'S THEORY AND TABLES OF SATURN.—We learn that M. Leverrier has completed his long-continued and exhaustive investigations on the motion of Saturn, and that his theory is reduced into tables, which will of course speedily take the place of those of Bouvard, or of provisional tables which have been used in the preparation of one or two of our ephemerides, pending the publication of others founded upon a more complete theory and discussion of the observations from the time of Bradley. As in all Leverrier's previous researches of a similar nature, he has made use of the rich store of observations accumulated at the Royal Observatory, Greenwich during upwards of 120 years, and also of the long series which has been formed at the Observatory of Paris. The mathematical astronomer will await the publication of M. Leverrier's researches in detail with extreme interest. The Tables of Saturn are understood to be necessarily of considerable extent, with the view to their convenient application.

THE GREAT COMET OF 1819.—The parabolic orbits so far computed for this comet, which was observed from the beginning of July to the middle of October, do not represent the observations with sufficient precision, and it is probable that no parabola will be found to do so. The following may, perhaps, be closer than any yet published:—

Perihelion passage	1819, June 27·71547, Greenwich M. T.	
Longitude of perihelion ...	287° 8′ 11″	Mean equinox July 0
Ascending node	273 41 57	
Inclination ...	80 44 38	
Log. perihelion distance ...	9·533233	
Heliocentric motion	direct.	

But this orbit exhibits differences from the observations of a kind that should probably be attributed to deviation from parabolic motion, and as we are in possession of many of the original observations, it would be desirable to discuss them with the view of determining the true character of the orbit in which the comet was moving. Its transit over the sun's disc, a nearly central transit, early on the morning of June 26, and the suspicion that it was actually observed upon the disc by Pastorff at Buchholz, or, as is even more probable, by Stark at Augsburg, give it a peculiar interest. The diagram of the comet's path across the sun, which appears in the "Berliner Astronomisches Jahrbuch," is erroneous; it would pass in greater longitude than that of the sun's centre, as indicated by the above elements, which in this respect are confirmed by the orbits of Nicolai, Dirksen, and Cacciatore. For the centre of the earth the ingress took place June 25 at 16h. 52m·9 mean time at Greenwich, 172° from the sun's north point towards the east (direct image), and the egress at 20h. 29m·9, about 9° from the same point to the east. For the time of transit the elements, no doubt, assign the comet's position within 15″ or 20″. The larger differences from observation are in August.

SCIENCE IN GERMANY

(*From a German Correspondent.*)

IN continuation of the previously reported investigations of the formation of cells in the ovum, we may mention some observations of Kupffer, which relate to a hitherto rather unknown yet doubtless very widely spread structure of the animal cell. ("On the differentiation of protoplasm in the cells of animal tissues," from "Schriften des naturwissenschaftlichen Vereins für Schleswig Holstein," Heft. iii.; and "The salivary glands of *Periplaneta orientalis* and its nervous system," from "Beiträge zur Anatomie und Physiologie, als Festgabe Carl Ludwig zum 15 Oct. 1874, gewidmet von seinen Schülern.") Kupffer first discovered that the body of the cells from the liver of a frog, which coat the biliary vessels, consists of two substances which chemically and physically are widely different, while hitherto it had been considered homogeneous throughout and had been called protoplasm. A hyaline ground substance (Paraplasm) gives to the body of the cell its relatively firm exterior shape, while in its interior a moveable, grained protoplasm is found in varying arrangement. It appears as a central mass round the nucleus, from which ramified or reticular threads radiate to the exterior side of the liver-cells which is turned towards the blood-vessels, or to that which borders the biliary vessels. From this arrangement of the protoplasm, which slowly flows in the well-known manner, Kupffer surmised that these were the ways in which certain matters were conveyed from the blood into the biliary vessels; and he found his opinion confirmed when he introduced soluble colouring matter into the blood of the living animals. As the colour entered through the liver-cells into the biliary vessels, it indicated its course through the cells in most cases in exactly the same way in which formerly the protoplasm proper had been found arranged. Similar facts were found in respect to the liver and kidneys of other Vertebrata, in the young back-teeth of calves, in certain glands of insects (Malpighian bodies). In the salivary glands of the well-known "black beetle" (*Periplaneta*), Kupffer not only found a very soft net of protoplasm-threads inside the ground-substance of the cells, but he also proved their connection with nerve ends. This likewise supports the view that the substance of the animal cell is differentiated in a manner similar to that of the vegetable cell, viz., that it consists of an active material which remains moveable and fulfils the special physiological functions of the single cell (protoplasm), and of a more passive material which forms a sort of protecting receptacle, as it were, for the tender protoplasm (Kupffer's paraplasm).

The "Archiv für mikroskopische Anatomie," edited by La Valette St. George and Waldeyer, has produced the following papers in its eleventh volume, up to this date:—Part I. On Radiolaria and fresh-water Radiolaria-Rhizopoda, by Greeff.—On bone growth, by Strelzow.—Researches on the physiology of the kidneys, by Wittich.—Studies on Rhizopoda, by F. E. Schulze.—Researches on the ganglion globules of the spinal ganglia, by Arndt.—On Heitzmann's hæmatoblasts, by Neumann.—On tissue cells by Waldeyer. Part II. The Ventriculus terminalis of the spinal marrow, by Krause.—Remarks on the nerves of dura mater, by Alexander.—Studies on the development of bones and of bone-tissue, by Stieda.—On the peripherical part of vertebræ, by Ehrlich.—The perivascular lymph-spaces in the central nervous system, and in the retina, by Riedel.—On cement layers in the tissues of vessels, by Adam-Kiewicz.—Hyalonema Siebold, Gray, by Küstermann.—Researches on the development of spermatozoa, by Neumann.—On amœboid motions of the little nucleus-body, by Eimer. Part III. Studies on Rhizopoda, by F. E. Schulze.—The relation of ciliated epithelium of the abdominal cavity to the epithelium of the ovary, by Neumann.—Researches on the first signs of the eye-lens, by Mihalkowics.—Vertebral side and cerebral appendage, by the same.—Researches on the development of cross-striped muscles and nerves of Reptilia and Amphibia, by Calberla.—On the reproduction of Arcella vulgaris, by Bütschli.—Researches on the epithelium of the nose, by Brunn.—On the nerves of the gullet, by Goniaew.—Researches on the anatomy of the human throat, by Disse.—On the structure of the Najadeuxieme, by Posner.—Supplement: On the dental system of Reptilia, and its significance with regard to the genesis of the skeleton of the oral cavity, by O. Hertwig.—The above-mentioned researches of Greeff and Schulze, which are in close relation with those made in England by Archer and Carter, treat of a class of the lower animals which only lately has attracted great attention; we therefore can hardly be astonished that in such treatises, descriptions and determinations of the different forms are in the majority, and that the particular course of life of single species remains at present still wrapped in considerable darkness. These neat little organisms consist of a very simple substance, which supports their existence (sarcode) and of a siliceous skeleton, which in some instances radiates outwardly in all directions, while in others it appears as a bag- or bottle-shaped shell, and is often adorned with relief-work well worthy of admiration. As indications seem to become more and more numerous that not only within the range of one species, but even in the development of one and the same individual animal, different forms occur, it is evident that the propagation and development of these organisms must remain difficult to understand, so long as these relative connections are not investigated. But thus much is already known, that even in the most distant localities the same forms may occur, and that the marine Radiolaria and Rhizopoda have near relations, or even identical forms, in fresh water. Besides division, the following phenomena seem to be connected with propagation: the phenomenon of conjugation (temporary union of two animals), of "encystifaction" (enclosing by a shell of the animal which is contracted into the shape of a ball), and of the formation of spores (production of interior germs, according to Bütschli).

ZOOLOGICAL STATIONS ABROAD

THE following letters from Dr. Mikluho-Maclay to Dr. Anton Dohrn, Director of the Zoological Station at Naples, have been forwarded to us for publication by Prof. Huxley. The first relates to a zoological station which Dr. Maclay has established in the Malay Archipelago, and the second to the general subject of zoological stations abroad.

"Dear Dohrn,—You are well aware that I share your views as to the great value of zoological stations to science, and you will not doubt that the account of the excellent results of the great establishment founded by you at Naples, which reached me by accident at Ternate in 1873 on my return from my first expedition to New Guinea, gave me great pleasure.

"It is now my turn to surprise you with the news of the establishment of a third (?)[1] *zoological station at the southernmost point of Asia*, on 'Selat-Tebrau,' the strait which divides the island of Singapore from the Malay Peninsula.

"This new 'station' cannot, it is true, be so called in the same sense as yours at Naples. I have taken my own requirements and customary mode of life as the standard, and have arranged the building and its fittings in accordance with it.

"It will serve in the first place as a station and *Tampat Senang* (or place of rest) for *myself*; in my absence, and after my death, I wish to place it at the disposal of any student of nature who feels himself suited for my mode of life.

"My 'Tampat Senang' has the following advantages to offer:—

"A house consisting of two fairly large rooms, each provided with two verandahs (besides the necessary offices), surrounded on three sides by the waters of the straits, and on the fourth by the primeval forest.

"The house will be simply furnished, and will contain a small library, together with the most necessary articles for housekeeping.

"It possesses, moreover, two advantages which I consider to be of no small importance, namely, the command of a fine view, and very complete isolation.

"The use of this 'Tampat Senang' is open to *any* student of nature, without the slightest regard to nationality, provided only he be of the male sex (for I confess to a decided repugnance to all stages of development and differentiation of the genus 'blue stocking.') The presence of a woman as visitor, or as supplement of the one student of nature for whom the place affords room—for in this case a wife must be so regarded—is not forbidden; but since 'Tampat Senang' must remain true to its name and to my idea, no children can possibly be allowed there.

"I have purchased the piece of land on which the house is to stand, from H.H. the Maharajah of Johore. It is a small hill which forms a cape projecting into the Selat Tebrau. In my will I have made such provisions that my family, into whose hands it will pass, will be precluded from *ever* selling it, or allowing it to be used for *any other* purpose than as a station for scientific research; or from cutting down, or even thinning the primeval woods standing upon it; the utmost that will be allowed is the clearance of one or two footpaths through the wood, which is always to remain as a specimen of the untouched primeval forest. And although 'Tampat Senang' may be hereafter rebuilt in stone, and made more elegant or convenient, it is *never* to be enlarged, lest it should lose its character of an isolated abode for *one* student of nature.

"I lose no time in writing to you, although the ground is only just purchased and the house is not yet built, because I think the plan of establishing such outposts for students of nature in these parts of the world (the East Indian Archipelago, Australia, the islands in the Pacific Ocean, Japan, &c., &c.) likely to be *very useful*, and also because, on account of my present ailment (an injured foot), I have more leisure than usual.

"Hotels can never afford suitable places of study on account of the noise and confusion inseparable from them; nor can the hospitality of friends, however kindly it may be offered, supply all that the student of nature needs. Such unpretending stations as my future 'Tampat Senang,' where he can work in absolute quiet, neither disturbing others, nor suffering interruptions, without the need of asking favours or incurring obligations, will I think commend themselves to many persons interested in the advancement of science.

"A principal reason for my choice of Johore is the neighbourhood of Singapore, from which place 'Tampat Senang' can be reached in three or four hours. The advantages of this position are that all products of European industry can be easily procured; that by means of the frequent mails communication can be maintained with all parts of the world; that very fair libraries are accessible at Singapore and Batavia; and that, at the latter place, scientific papers can be published in French, German, or Dutch, in the *Natuurkundig Tijdschrift*, while the *Journal of Eastern Asia*, of Singapore, publishes similar works in English.

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[1] I have not heard whether the station which you and I began at Messina in 1867-68 arrived at any high degree of development, or whether it shrank into a mere rudiment. My nomad life has prevented news of any other than yours at Naples from reaching me; for example, I do not know whether the station on the Black Sea, which I advocated at the meeting of Russian naturalists at Moscow in 1868, ever came into existence.

"In the hope that you may be one of those who will make use of my 'Tampat Senang,' I remain, with all respect and friendship, "N. N. MIKLUHO-MACLAY

"28th April, 1875, Istana Johore,
"Residence of H.H. the Maharajah of Johore."

"In life, as in everything else, it is important to distinguish main points from secondary matter, and to act accordingly. Main points always remain main points, however important secondary objects may sometimes be. On account of this evidently correct view, I continue my journey into the interior of the Malayian peninsula, as my health is improving; to-morrow I shall go to Pahang, and for the moment I give up building the 'Tampat Senang.' It is possible that I must try and find some other locality than Johore for this, because the Maharajah of Johore, after nearly two months' talking, in which time I had made out all the plans and had completely gone through all the details of the proposed building, has at last declared to me that he only could let me have that tract of land which I had chosen for the 'Tampat Senang' for a certain number of years, and that he must retain certain rights on the same. As all this does not agree with my plans, and as the locality is not of decisive importance, I shall, in case the Maharajah does not decide differently, construct my 'Tampat Senang' somewhere else.

"I consider the foundation of Zoological Stations in the tropics (however simply and poorly they may be fitted out, if they are otherwise quiet and comfortable places for work) as of the greatest importance for zoology and botany, since museum collections and preparations in spirits cannot afford sufficient material for investigation either with regard to quantity or quality.

"I have sent a proposal to the Society of Naturalists at Batavia, to found a 'Tampat Senang' [1] for naturalists in the Moluccas (at Amboina or at Ternate), and I intend to send similar proposals to scientific societies at Calcutta, and in Australia, and to some friends in Chile. If Russian Societies of Naturalists assist me I intend eventually to found a Zoological Station at the Sea of Ochotsk, or on the Pacific Ocean, myself.

"Zoological Stations in the Moluccas, in the Himalayan Mountains, in Tasmania, in the Fiji Islands, in Magellan's Straits, in Kamtschatka, &c., will yield not a few important results for all natural sciences. These stations will be particularly important for those naturalists who travel not only as tourists or as trade travellers of science, as it were, but who are engaged on some special work which requires large and fresh materials. Upon my return (which, however, is very uncertain at present) I will communicate to you my plans on the 'Tampat Senang' (the name seems to me to be quite appropriate) in detail. As it seems to me, they must be somewhat different from such Zoological Stations as your own at Naples, or we shall have to wait too long for their foundation. On my part I shall do all in my power for the carrying out of this idea, which nevertheless must remain a secondary (although important) object for *myself*.

"The day before yesterday I read in NATURE of May 6 of the official inauguration of your station at Naples, with much pleasure, and amongst the names I found those of several friends and acquaintances; so that I am led to hope that the scientific world will be interested in the 'Tampat Senang' in other parts of the globe.

"My kindest regards to yourself and all workers at the Zoological Station of Naples.

"N. N. MIKLUHO-MACLAY
"Istana, Johore, 9th May (June?) 1875"

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[1] It is a matter of course that what I expect from my future "Tampat Senang" cannot apply to others. Only mine shall remain true to its name, whether built at Johore, or at the Maclay coast in New Guinea.

THE VATNA JÖKULL, ICELAND

THE following letter from Mr. W. L. Watts in reference to his journey across the Vatna Jökull has been forwarded to us by Mr. Logan Lobley. As we noted last week, this is the first time the Vatna Jökull has been crossed. The letter is dated "Grierestadir, by Jökull sá á fjöllum (Iceland), July 12, 1875."

"I am happy to say I have crossed the Vatna Jökull. It occupied between fifteen and sixteen days in bad weather. Euriffa is by no means the highest mountain in Iceland; my aneroids registered 1,250 feet above Euriffa's height, subject to their correction upon my return to England.

"I feel certain that the Jökulls of Iceland are advancing at a considerable speed. The part of the Vatua Jökull, in the south of Iceland, called Breithamerker Jökull, has advanced about one mile and a half since the 10th of May last, and threatens to cut off all communication in that direction along the shore. I think, however, its rapid advance is not, as the natives believe, owing to volcanic heat in the Vatna Jökull, but that it is caused simply by the vast increase of frozen material upon its cloud and storm-wrapped heights. This accumulation above the height of 5,000 feet goes on both in summer and winter, and below for another thousand feet the waste during the summer months by no means equals the accumulation during the rest of the year. The glacier at the north point, at which descended, by Kistufell has advanced about twelve miles since the making of Olsen's map of 1844, diverting the course of the Jökull sá á fjöllum and causing it to rise about twelve miles from where it appears to do upon the map, *i.e.* about eleven miles N.E. of Kistufell and twelve NN.W. of Kverker Jökull, instead of at the base of Kistufell. The grand old water-course it has vacated forms an excellent road for several miles. I feel sure Iceland must slowly but surely in course of time succumb to the same fate as befell the Greenland colonies.

"I am now about to proceed to the active volcanoes upon the north of Vatna Jökull. They are situated in the part of the Odalters-braun called Dyngurfjöllum, and as I expect in the Kverker Jökull. I shall have no time to hunt for any more this year, but if time will allow I shall visit the source of the great lava stream of Skaptar Jökull, a mountain I saw from the Vatna Jökull, situated in its S.W. limb, which I think may repay inspection; and the lignite in the N.W. of Iceland.

"The destruction wrought by the eruptions of last winter is considerable. Several farms have been ruined by pumice and ash. Poor, dirty, interesting Iceland! both fire and water, the latter in all its forms, appear to conspire against it."

ON AN IMPROVED OPTICAL ARRANGEMENT FOR AZIMUTHAL CONDENSING APPARATUS FOR LIGHTHOUSES

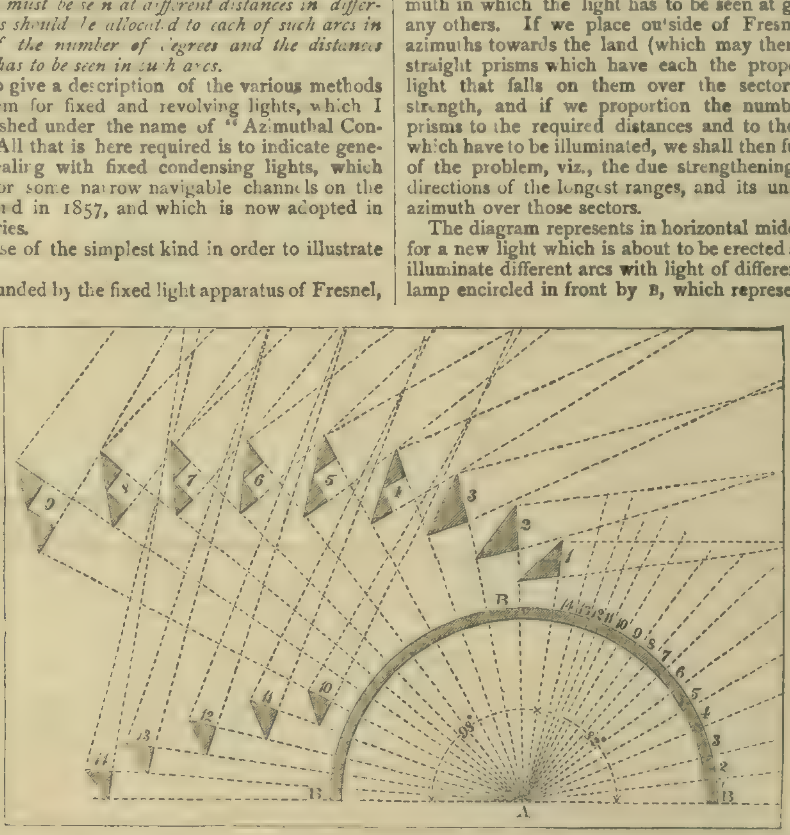
ORDINARY optical apparatus adapted for a lighthouse which has to illuminate the whole horizon, as at rock or insular stations, is unsuitable for stations situate on the coast line, or in narrow sounds, where the light has in some azimuths to be seen at great distances, in others at smaller, and where towards the land no light is wanted at all. The problem in such cases is to allocate the rays in the different azimuths in proportion to the distances and breadths of sea in which the light requires to be seen in those directions by the sailor. Before 1855 no attempt was made to deal with this question, excepting the simple expedient of placing a spherical mirror on the landward side, where no light was wanted, and thus the rays intercepted by the mirror were reflected back again through the flame, so as to be ultimately acted on by the apparatus at the seaward side. But this device did not in any way fulfil the condition of allocating the rays proportionally to the varying distances at which the light had to be seen in the different azimuths, nor to the amplitude of the arcs. What was required was *a system by which the whole light from the lamp should be spread horizontally and with strict equality over any given arc in azimuth; and at a light of unequal range, which must be seen at different distances in different azimuths, the rays should be allocated to each of such arcs in the compound ratio of the number of degrees and the distances from which the light has to be seen in such arcs.*

It is unnecessary to give a description of the various methods of solving this problem for fixed and revolving lights, which I have elsewhere published under the name of "Azimuthal Condensing Lights."[1] All that is here required is to indicate generally the mode of dealing with fixed condensing lights, which was first employed for some narrow navigable channels on the west coast of Scotland in 1857, and which is now adopted in many different countries.

We shall take a case of the simplest kind in order to illustrate the principle:—

Let a lamp be surrounded by the fixed light apparatus of Fresnel, which allows the rays to pass through it unaltered in direction in azimuth, so as thus to show a light of equal intensity all round the horizon, but which operates on the rays in altitude by bending upwards, to the horizontal, those rays which would fall on the lightroom floor and be lost, and also by bending downwards to the horizontal those rays which would naturally pass up to the clouds. This instrument then strengthens the light passing to the sailor's eye, by bending upwards and downwards those rays which would otherwise be entirely lost. Suppose, however, that the light does not require to be seen at all in an arc in the direction of the land, and that there are two other sectors in azimuth in which the light has to be seen at greater distances than any others. If we place outside of Fresnel's apparatus in the azimuths towards the land (which may therefore be made dark) straight prisms which have each the property of spreading the light that falls on them over the sectors that require most strength, and if we proportion the number of these straight prisms to the required distances and to the number of degrees which have to be illuminated, we shall then fulfil this simplest case of the problem, viz., the due strengthening of the light in the directions of the longest ranges, and its uniform distribution in azimuth over those sectors.

The diagram represents in horizontal middle section the design for a new light which is about to be erected and which requires to illuminate different arcs with light of different intensity. A is the lamp encircled in front by B, which represents part of Fresnel's fixed light apparatus, outside of which are shown straight vertical prisms numbered 1 to 14 for condensing the rays over the arcs in azimuth that have to be strengthened, and which arcs have corresponding numbers 1 to 14. The novelty in this arrangement is the mode adopted for reducing the space which would otherwise be occupied by the condensing prisms but for which there is no room in a lantern of ordinary size.



My friend Prof. Swan, of St. Andrews, among other ingenious devices in a paper read to the Royal Scottish Society of Arts, proposed, in order to reduce the space occupied by the apparatus, to place prisms *behind* others and to project the rays from the prisms behind, forwards through spaces left between the prisms in front. In the present design I have availed myself of this proposal. The prisms 10 to 14 throw their light between the prisms 3 to 8. Owing, however, to the natural divergence due to the size of the flame, much useful light would be lost by impinging against the edges of the outer prisms unless those prisms were separated farther from each other in order to afford wider spaces for the cones of light to pass through. But this again would increase the space occupied by the apparatus. The difficulty may be overcome by cutting out the apex of the outer prisms as shown in prisms 4 to 9. This would, as in Buffon's annular lens, also materially reduce the absorption of the light which passes through them. For facility of construction, however, instead of one prism cut in this manner, two small separate prisms arranged symmetrically with the larger one have been substituted.[1] By means of these groups of *twin prisms* the apparatus is reduced within practicable dimensions, while the quantity of glass employed in the apparatus is materially lessened, and the loss from absorption is reduced by about one-tenth.

It is only necessary to add that while the cost of the first apparatus of the kind will be increased by the greater number of moulds required for casting the prisms, it will on the other hand be reduced by the smaller quantity of glass required. The amount of glass surface which has to be ground and polished is of course the same for each pair of twin prisms as for one single large prism.

The new apparatus will, in addition to what has been described, require at the back of the flame the Dioptric spherical mirror which I proposed in 1849[2] with the improvements suggested by Mr. J. T. Chance in 1862, and above the flame, prisms of the new forms suggested by Mr. Brebner and myself; and also independently by Prof. Swan, and which were first introduced at Lochindaal in Argyllshire, in 1869.[3] The apparatus will therefore embrace in all six different optical agents, and will compress into one sector of 82° light which would naturally diverge uselessly over 278°. This condensing apparatus is, however, not nearly so powerful as others now in use. In the two which I designed for Buddonness-on-the-Tay, one of which was exhibited at the Paris International Exhibition, the whole sphere of light was compressed into one sector of 45°, and in another design lately made for the Colonies the light is condensed into 30°.

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[1] Edin. New Phil. Journal, 1855, p. 273. "Lighthouse Illumination," Edinburgh, 1871; second edition, p. 79.

[1] If the prism be of large size, more than two prisms may of course be substituted.

[2] Trans. Roy. Scott. Soc. of Arts, 1850.

[3] "Lighthouse Illumination," p. 75.

THOMAS STEVENSON

THE BRITISH ASSOCIATION

BRISTOL, *Tuesday Evening*

BRISTOL bids fair fully to accomplish its intention of giving the Association one of the best receptions it has ever received. When the visitor has laboured through the inconveniences of the railway station, and got fairly at home in this region of hills and valleys, and cliffs and quays, and churches and chimney stacks, he will find himself as happily situated as anyone but a confirmed grumbler could wish.

The local committee have evidently spared no expense to increase the comfort of visitors. The engagement of the entire Victoria Rooms for reception rooms has given ample space for almost every requirement. The great hall itself contains many of the necessary offices, including those for the local officials, sale of tickets of all kinds, distribution of printed circulars, and a telegraph and post-office; in addition, Messrs. Bingham's book-stall supplies all kinds of journals and scientific publications. A first-rate refreshment room occupies one of the smaller halls, and a reasonable tariff of prices is published. Almost every want seems to have been anticipated, and the honorary local secretaries, Messrs. W. Lant Carpenter and J. F. Clarke, with many other zealous workers, have been labouring untiringly to have everything in order. So successful were they, that the reception rooms were opened exactly at the moment previously announced—one o'clock on Monday; and the first rush to secure tickets was most satisfactorily worked off. It will be surprising if the amount expended do not exceed the local subscription of 2,400*l.* At any rate, so far as experience goes at present, that full success is likely to be realised which is worth very much more than can be measured by money. The Mayor (Mr. Thomas) to-day took up his residence at the Mansion House, where he will receive the President-elect, Lady Hawkshaw, and other distinguished visitors. Most of the notable visitors come as invited guests.

The columns of NATURE would certainly fail me if I attempted to enumerate the objects of interest here which are thrown open freely to members of the Association. Churches, old buildings of all kinds, libraries, ships, quays, warehouses, parks, and mansions are alike at the disposal of the visitors.

Notable amongst hospitalities will be the banquet of the Merchant Venturers' Society, at which about a hundred of the leading members of the Association will be entertained on Tuesday evening next. The hall of the Merchant Venturers has lately been decorated with a magnificence worthy of their distinguished history. The sovereigns who granted them charters, the Bristol worthies, Edward Colston, Alderman Whitson, Sebastian Cabot, William Canynge, and Thomas Daniel are all commemorated by portraits or arms; while the staircase and vestibule bear significant emblems of seafaring life. Saturday next is the jubilee of the Bath Royal Literary and Scientific Institution. This will be celebrated by a public meeting and banquet, presided over by the Earl of Cork, lord-lieutenant of the county. Sir John Hawkshaw and many other distinguished guests are expected.

As a matter of course nearly all the eminent British men of science are expected to be present, and many of them have already arrived. Among foreign visitors who have arrived or are expected, there are Prof. Paul Gervais, of Paris; Chevalier Negri, President of the Geographical Society of Turin; Chevalier Bergeron, C.E., Paris; Prof. Geinitz, Dresden; Prof. Hébert, Paris; Dr. Leitner; Prof. Youmans, United States; Mr. H. A. Rowland, Baltimore; Prof. Janssen, Paris; M. Léon Vanderkinden, Brussels University; Dr. A. Oppenheim, Berlin; Colonel Carrington, Wabash College, U.S.

Of course the general meetings, inaugural address, lectures, and soirées will be given in the Colston's Hall, which can seat 3,000 persons. The sections are accommodated in a number of buildings extending along one line of thoroughfare, from the Wesleyan schoolroom in Victoria Place to the Royal Hotel at College Green. Sections A and G sit in the Fine Arts Academy; B in the Lecture Theatre, Freemasons' Hall; C in the New Museum Lecture Room; D in three departments at Hamilton's Rooms, Park Street, the Grammar School, and the Royal Hotel; E in the Blind Asylum Music Room; F in the schoolroom of Victoria Chapel. On the back of every Association Ticket a plain map of about one square mile of Clifton is printed, showing in red colours all the buildings used for meetings. This is a most valuable help for visitors.

A first-rate loan museum is exhibited in the new portion of the Museum buildings, and is well worthy of attention. Among the most interesting things to be seen are specimens from many local collieries of every vein of coal they work, local building-stones and clays; and capital illustrations of local zoology and botany. The Museum proper is noticeable for its splendid collection of Triassic reptiles, Labyrinthodonts, and Palæozoic fishes, especially *Thecodontosaurus* and *Ceratodus.* A splendid skeleton of *Ichthyosaurus platyodon* has just been mounted. It was detected by Mr. Tawney on the beach near Lyme Regis, close to low-water mark. It was brought up in large fragments of over a hundred-weight, in all over a ton, and developed under Mr. Tawney's superintendence. The skeleton is swung instead of being supported from beneath, according to an idea of Dr. H. Fripp, and it can be examined very closely, and on both sides, being placed on a stand of the ordinary height of table cases. It was an enormous individual. The present remains, although lacking the snout and much of the tail, extend to a length of about twenty-five feet.

The excursions for Thursday week are numerous and calculated to please all tastes; they are to (1) Bath, (2) Bowood and Avebury, (3) Cheddar, (4) Chepstow and Tintern, (5) Portishead, Cadbury Camp, and Clevedon, (6) Salisbury and Stonehenge, (7) Sources of Bristol Waterworks Supply, (8) Tortworth and Damery Bridge, (9) Wells and Cheddar, (10) Weston-super-Mare.

The arrangements for transit and entertainment are most complete. The soirées give promise of great success. The first is to be under the auspices of the Bristol and Bath Natural History Societies, and many specimens of living microscopic animals will be exhibited. At the second, the post office officials intend to make a very elaborate display of telegraphic instruments and processes.

It is worthy of remark that it was at the meeting of the Association at Bristol in 1836 that Section G (Mechanical) was instituted; and at that meeting Dr. Lardner expressed his opinion that the proposed scheme of crossing the Atlantic by steam was an impossibility. From Bristol, however, the first steam-ship traversed the Atlantic to New York.

It was in the Bristol district that macadamised roads were first introduced; some of the earliest docks (1805) were made there under the direction of Mr. W. Jessop; and on the Somersetshire Canal was tried Mr. Weldon's extraordinary hydrostatic lock.

To geologists there is the interesting fact that within twelve miles on the Somersetshire Coal Canal, the "father of English geology" made his discovery of the sequence of strata; and geographers will recollect that Sebastian Cabot sailed from Bristol.

INAUGURAL ADDRESS OF SIR JOHN HAWKSHAW, F.R.S., PRESIDENT.

To those on whom the British Association confers the honour of presiding over its meetings, the choice of a subject presents some difficulty.

The Presidents of Sections, at each annual meeting, give an account of what is new in their respective departments; and essays on science in general, though desirable and interesting in the earlier years of the Association, would be less appropriate to-day.

Past Presidents have already discoursed on many subjects, on things organic and inorganic, on the mind and on things perhaps beyond the reach of mind, and I have arrived at the conclusion that humbler themes will not be out of place on this occasion.

I propose in this Address to say something of a profession to which my lifetime has been devoted—a theme which cannot perhaps be expected to stand as high in your estimation as in my own, and I may have some difficulty in making it interesting; but I have chosen it because it is a subject I ought to understand better than any other. I propose to say something on its origin, its work, and kindred topics.

Rapid as has been the growth of knowledge and skill as applied to the art of the engineer during the last century, we must, if we would trace its origin, seek far back among the earliest evidences of civilisation.

In early times, when settled communities were few and isolated, the opportunities for the interchange of knowledge were scanty or wanting altogether. Often the slowly accumulated results of the experience of the wisest heads and the most skilful hands of a community were lost on its downfall. Inventions of one period were lost and found again. Many a patient investigator has puzzled his brain in trying to solve a problem which had yielded to a more fortunate labourer in the same field some centuries before.

The ancient Egyptians had a knowledge of Metallurgy, much of which was lost during the years of decline which followed the golden age of their civilisation. The art of casting bronze over iron was known to the Assyrians, though it has only lately been introduced into modern metallurgy; and patents were granted in 1609 for processes connected with the manufacture of glass, which had been practised centuries before.[1] An inventor in the reign of Tiberius devised a method of producing flexible glass, but the manufactory of the artist was totally destroyed, we are told, in order to prevent the manufacture of copper, silver, and gold from becoming depreciated.[2]

Again and again engineers as well as others have made mistakes from not knowing what those had done who have gone before them, and have had the same difficulties to contend with. In the long discussion which took place as to the practicability of making the Suez Canal, an early objection was brought against it that there was a difference of 32½ feet between the level of the Red Sea and that of the Mediterranean. Laplace at once declared that such could not be the case, for the mean level of the sea was the same on all parts of the globe. Centuries before the time of Laplace the same objection had been raised against a project for joining the waters of these two seas. According to the old Greek and Roman historians, it was a fear of flooding Egypt with the waters of the Red Sea that made Darius, and in later times again Ptolemy, hesitate to open the canal between Suez and the Nile.[3] Yet this canal was made, and was in use some centuries before the time of Darius.

Strabo[4] tells us that the same objection, that the adjoining seas were of different levels, was made by his engineers to Demetrius,[5] who wished to cut a canal through the Isthmus of Corinth some two thousand years ago. But Strabo[6] dismisses at once this idea of a difference of level, agreeing with Archimedes that the force of gravity spreads the sea equally over the earth.

When knowledge in its higher branches was confined to a few, those who possessed it were often called upon to perform many and various services for the communities to which they belonged; and we find mathematicians and astronomers, painters and sculptors, and priests called upon to perform the duties which now pertain to the profession of the architect and the engineer. And as soon as civilisation had advanced so far as to admit of the accumulation of wealth and power, then kings and rulers sought to add to their glory while living by the erection of magnificent dwelling-places, and to provide for their aggrandizement after death by the construction of costly tombs and temples. Accordingly we soon find men of ability and learning devoting a great part of their time to building and architecture, and the post of architect became one of honour and profit. In one of the most ancient quarries of Egypt a royal high architect of the dynasty of the Psammetici has left his pedigree sculptured on the rock, extending back for twenty-three generations, all of whom held the same post in succession in connection with considerable sacerdotal offices.[1]

As there were in these remote times officers whose duty it was to design and construct, so also there were those whose duty it was to maintain and repair the royal palaces and temples. In Assyria, 700 years before our era, as we know from a tablet found in the palace of Sennacherib by Mr. Smith, there was an officer whose title was the Master of Works. The tablet I allude to is inscribed with a petition to the king from an officer in charge of a palace, requesting that the master of works may be sent to attend to some repairs which were much needed at the time.[2]

Under the Roman Empire there was almost as great a division of labour in connection with building and design as now exists. The great works of that period were executed and maintained by an army of officers and workmen, who had special duties assigned to each of them.

Passing by those early attempts at design and construction which supplied the mere wants of the individual and the household, it is to the East that we must turn if we would find the earliest works which display a knowledge of engineering. Whether the knowledge of engineering, if we may so call it, possessed by the people of Chaldæa and Babylonia was of native growth or was borrowed from Egypt is, perhaps, a question which cannot yet be answered. Both people were agricultural, dwelling on fertile plains, intersected by great rivers, with a soil requiring water only to enable it to bring forth inexhaustible crops. Similar circumstances would create similar wants, and stimulate to action similar faculties to satisfy them. Apart from the question of priority of knowledge, we know that at a very early period, some four or five thousand years ago at least, there were men in Mesopotamia and Egypt who possessed considerable mechanical knowledge, and no little skill in hydraulic engineering. Of the men themselves we know little; happily, works often remain when the names of those who conceived and executed them have long been forgotten.

It has been said that architecture had its origin not only in nature, but in religion; and if we regard the earliest works which required mechanical knowledge and skill, the same may be said of engineering. The largest stones were chosen for sacred buildings, that they might be more enduring as well as more imposing, thereby calling for improvement and invention of mechanical contrivances, to assist in transporting and elevating them to the position they were to occupy; for the same reason the hardest and most costly materials were chosen, calling for further improvement in the metal forming the tools required to work them. The working of metals was further perfected in making images of the gods, and in adorning with the more precious and ornamental sorts the interior and even external parts of their shrines.

The earliest buildings of stone to which we can assign a date with any approach to accuracy, are the pyramids of Gizeh. To their builders they were sacred buildings, even more sacred than their temples or temple palaces. They were built to preserve the royal remains, until, after a lapse of 3,000 years, which we have reason to believe was the period assigned, the spirit which had once animated the body should re-enter it.[3] Although built 5,000 years ago, the masonry of the Pyramids could not be surpassed in these days; all those who have seen and examined them, as I myself have done, agree in this; moreover, the design is perfect for the purpose for which they were intended, above all to endure. The building of pyramids in Egypt continued for some ten centuries, and from 60 to 70 still remain, but none are so admirably constructed as those of Gizeh. Still, many contain enormous blocks of granite from 30 to 40 feet long, weighing more than 300 tons, and display the greatest ingenuity in the way in which the sepulchral chambers are constructed and concealed.[4]

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[1] Layard's "Nineveh and Babylon," p. 191; Beckman's "History of Inventions," vol. ii. p. 85.

[2] Pliny, Nat. Hist., bk. xxxvi. c. 66.

[3] Ibid., bk. vi. c. 33.

[4] Strabo, c. iii § 11.

[5] Demetrius I., King of Macedonia, died 283 B.C.

[6] Strabo, c. iii. § 12.

[1] "Discoveries in Egypt, Ethiopa, &c.," by Dr. Lepsius, 2nd edit. p. 318

[2] Smith's (G.) "Assyrian Discoveries," 2nd edit. p. 414.

[3] Fergusson's "History of Architecture," vol. i. p. 83; Wilkinson "Ancient Egyptians," 2nd series, vol. ii. p. 444.

[4] Vyse's "Pyramid's of Gizeh," vol. iii. pp. 16, 41, 45, 57.

The genius for dealing with large masses in building did not pass away with the pyramid builders in Egypt, but their descendants continued to gain in mechanical knowledge, judging from the enormous blocks which they handled with precision. When the command of human labour was unlimited, the mere transport of such blocks as the statue of Rameses the Great, for instance, which weighed over 800 tons, need not so greatly excite our wonder; and we know how such blocks were moved from place to place, for it is shown on the wall paintings of tombs of the period which still remain.

But as the weight of the mass to be moved is increased, it becomes no longer a question of only providing force in the shape of human bone and muscle. In moving in the last century the block which now forms the base for the statue of Peter the Great, at St. Petersburg, and which weighs 1,200 tons, force could be applied as much as was wanted, but great difficulty was experienced in supporting it, and the iron balls on which it was proposed to roll the block along were crushed, and a harder metal had to be substituted.[1] To facilitate the transport of material, the Egyptians made solid causeways of granite from the Nile to the Pyramids; and in the opinion of Herodotus, who saw them, the causeways were more wonderful works than the Pyramids themselves.[2]

The Egyptians have left no record of how they accomplished a far more difficult operation than the mere transport of weight—that is, how they erected obelisks weighing more than 400 tons. Some of these obelisks must have been lifted vertically to place them in position, as they were by Fontana in Rome in later times, when the knowledge of mechanics, we know, was far advanced.[3]

The practice of using large blocks of stone either as monoliths or as forming parts of structures has existed from the earliest times in all parts of the world.

The Peruvians used blocks weighing from 15 to 20 tons, and fitted them with the greatest nicety in their cleverly designed fortifications.[4]

In India large blocks were used in bridges when the repugnance of Indian builders to the use of the arch rendered them necessary, or in temples, where, as in the Temple of the Sun at Orissa, stones weighing from 20 to 30 tons form part of the pyramidal roof at a height of from 70 to 80 feet from the ground.[5] Even as late as the last century, Indians, without the aid of machinery, were using blocks of granite above 40 feet long for the doorposts of the gateway of Seringham, and roofing blocks of the same stone for a span of 21 feet.[6]

At Persepolis, in the striking remains of the palaces of Xerxes and Darius, more than one traveller has noted the great size of the stones, some of which are stated to be 55 feet long and 6 to 10 feet broad.

So in the Greek temples of Sicily, many of the blocks in the upper parts of the temples are from 10 to 20 tons weight.

The Romans, though they did not commonly use such large stones in their own constructions, carried off the largest obelisks from Egypt and erected them at Rome, where more are now to be found than remain in Egypt. In the temples of Baalbek, erected under Roman rule, perhaps the largest stones are to be found which have been used for building since the time of the Pharaohs. The terrace wall of one of the temples is composed of three courses of stones, none of which are less than 30 feet long; and one stone still lies in the quarry squared and ready for transport, which is 70 feet long and 14 feet square, and weighs upwards of 1,135 tons, or nearly as much as one of the tubes of the Britannia Bridge.

I have not mentioned dolmens and menhirs, rude unhewn stones often weighing from 30 or 40 tons, which are found from Ireland to India, and from Scandinavia to the Atlas, in Africa. To transport and erect such rude masses required little mechanical knowledge or skill, and the operation has excited more wonder than it deserves. Moreover, Fergusson has gone far to show that the date assigned to many of them hitherto has been far too remote; most, and possibly all, of those in northern and western Europe having been erected since the time of the Roman occupation. And to this day the same author shows that menhirs, single stones often weighing over 20 tons, are erected by hill tribes of India in close proximity to stone buildings of elaborate design and finished execution, erected by another race of men.[1]

For whatever purpose these vast stones were selected—whether to enhance the value or to prolong the endurance of the buildings of which they formed a part—the tax on the ingenuity of those who moved and placed them must have tended to advance the knowledge of mechanical appliances.

The ancient Assyrians and Egyptians had possibly more knowledge of mechanical appliances than they are generally credited with. In the wall paintings and sculptures which show their mode of transporting large blocks of stone, the lever is the only mechanical power represented, and which they appear to have used in such operations; nor ought we to expect to find any other used, for, where the supply of human labour was unlimited, the most expeditious mode of dragging a heavy weight along would be by human power; to have applied pulleys and capstans, such as would now be employed in similar undertakings, would have been mere waste of time. In some countries, even now, where manual labour is more plentiful than mechanical appliances, large numbers of men are employed to transport heavy weights, and do the work in less time than it could be done with all our modern mechanical appliances. In other operations, such as raising obelisks, or the large stones used in their temple palaces, where human labour could not be applied to such advantage, it is quite possible that the Egyptians used mechanical aids. On one of the carved slabs which formed part of the wall panelling of the palace of Sardanapalus, which was built about 930 years before our era, a single pulley is clearly shown, by which a man is in the act of raising a bucket—probably drawing water from a well.[2]

It has sometimes been questioned whether the Egyptians had a knowledge of steel. It seems unreasonable to deny them this knowledge. Iron was known at the earliest times of which we have any record. It is often mentioned in the Bible, and in Homer; it is shown in the early paintings on the walls of the tombs at Thebes, where butchers are represented as sharpening their knives on pieces of metal coloured blue, which were most probably pieces of steel.[3] Iron has been found in quantity in the ruined palaces of Assyria; and in the inscriptions of that country fetters are spoken of as having been made of iron, which is also so mentioned in connection with other metals as to lead to the supposition that it was regarded as a base and common metal. Moreover, in the Great Pyramid a piece of iron was found in a place where it must have lain for 5,000 years.[4] The tendency of iron to oxidize must render its preservation for any long period rare and exceptional. The quality of iron which is now made by the native races of Africa and India is that which is known as wrought iron; in ancient times, Dr. Percy says the iron which was made was always wrought iron. It is very nearly pure iron, and a very small addition of carbon would convert it into steel. Dr. Percy says the extraction of good malleable iron directly from the ore "requires a degree of skill very far inferior to that which is implied in the manufacture of bronze."[5] And there is no great secret in making steel; the natives of India now make excellent steel in the most primitive way, which they have practised from time immemorial. When steel is to be made, the proportion of charcoal used with a given quantity of ore is somewhat larger, and the blast is applied more slowly than when wrought iron is the metal required.[6] Thus, a vigorous native working the bellows of skin would make wrought iron where a lazy one would have made steel. The only apparatus required for the manufacture of the finest steel from iron ore is some clay for making a small furnace four feet high, and from one to two broad, some charcoal for fuel, and a skin with a bamboo tuyere for creating the blast.

The supply of iron in India as early as the fourth and fifth centuries seems to have been unlimited. The iron pillar of Delhi is a remarkable work for such an early period. It is a single piece of wrought iron 50 feet in length, and it weighs not less than 17 tons.[7] How the Indians forged this large mass of iron and other heavy pieces which their distrust of the arch led them to use in the construction of roofs, we do not know. In the temples of Orissa iron was used in large masses as beams or girders in roof-work in the thirteenth century.[1]

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[1] Rondelet's "Traité de l'Art de Bâtir,' vol. i. p. 73.

[2] Herodotus, bk. ii. c. 124.

[3] For obelisk erected at Arles, 1675, see Rondelet's "L'Art de Bâtir," vol. i. p. 48. Its weight was nearly 200 tons, and it was suspended vertically by light ships' masts

[4] Fergusson's "History of Architecture," vol. ii. p. 779; Squier, "Peru," p. 24.

[5] The Temple of the Sun was built 1237-1282 A.D.—Hunter's "Orissa," vol. i pp. 288, 297.

[6] Fergusson's "Rude Stone Monuments," p. 96.

[1] Fergusson's "Rude Stone Monuments," pp 461-465.

[2] Layard's "Nineveh and its Remains," vol. ii. p. 31.

[3] Wilkinson's "Ancient Egyptians," vol. iii. p. 247.

[4] Vyse's "Pyramids of Gizeh," vol. i. p. 275.

[5] Percy's "Iron and Steel," p. 873.

[6] Ibid. p. 259.

[7] Fergusson's "History of Architecture," vol. ii. p. 460; and "Rude Stone Monuments," pp. 481-3. Cunningham's "Archæological Survey of India," vol. i. p. 169.

The influence of the discovery of iron on the progress of art and science cannot be over-estimated. India well repaid any advantage which she may have derived from the early civilised communities of the West if she were the first to supply them with iron and steel.

An interesting social problem is afforded by a comparison of the relative conditions of India and this country at the present time. India, from thirty to forty centuries ago, was skilled in the manufacture of iron and cotton goods, which manufactures, in less than a century, have done so much for this country. It is true that in India coal is not so abundant or so universally distributed as in this country. Yet, if we look still further to the East, China had probably knowledge of the use of metals as soon as India, and moreover had a boundless store of iron and coal. Baron Richthofen, who has visited and described some of the coal-fields of China, believes that one province alone, that of Southern Shanshi, could supply the world at its present rate of consumption for several thousand years. The coal is near the surface, and iron abounds with it. Marco Polo tells us that coal was universally used as fuel in the parts of China which he visited towards the end of the fourteenth century, and from other sources we have reason to believe it was used there as fuel 2,000 years ago. But what progress has China made in the last ten centuries? A great future is undoubtedly in store for that country; but can the race who now dwell there develop its resources, or must they await the aid of an Aryan race? Or is anything more necessary than a change of institutions, which might come unexpectedly, as in Japan?

The art of extracting metals from the ore was practised at a very early date in this country. The existence long ago of tin mines in Cornwall, which are so often spoken of by classical writers, is well known to all. That iron was also extracted from the ore by the ancient Britons is most probable, as it was largely used for many purposes by them before the Roman conquest. The Romans worked iron extensively in the Weald of Kent, as we assume from the large heaps of slag containing Roman coins which still remain there. The Romans always availed themselves of the mineral wealth of the countries which they conquered, and their mining operations were often carried out on the largest scale, as in Spain, for instance, where as many as forty thousand miners were regularly employed in the mines at New Carthage.[2]

Coal, which was used for ordinary purposes in England as early as the ninth century, does not appear to have been largely used for iron smelting until the eighteenth century, though a patent was granted for smelting iron with coal in the year 1611.[3] The use of charcoal for that purpose was not given up until the beginning of this century, since which period an enormous increase in the mining and metallurgical industries has taken place; the quantity of coal raised in the United Kingdom in 1873 having amounted to 127 million tons, and the quantity of pig iron to upwards of 6½ million tons.

The early building energy of the world was chiefly spent on the erection of tombs, temples, and palaces.

While, in Egypt, as we have seen, the art of building in stone had 5,000 years ago reached the greatest perfection, so in Mesopotamia the art of building with brick, the only available material in that country, was in an equally advanced state some ten centuries later. That buildings of such a material have lasted to this day shows how well the work was done; their ruinous condition even now is owing to their having served as quarries for the last three or four thousand years, so that the name of Nebuchadnezzar, apparently one of the greatest builders of ancient times, is as common on the bricks of many modern towns in Persia as it was in old times in Babylon. The labour required to construct the brick temples and palaces of Chaldæa and Assyria must have been enormous. The mound of Koyunjik alone contained 14½ million tons, and represents the labour of 10,000 men for twelve years. The palace of Sennacherib, which stood on this mound, was probably the largest ever built by any one monarch, containing as it did more than two miles of walls, panelled with sculptured alabaster slabs, and twenty-seven portals, formed by colossal bulls and sphinxes.[4]

The pyramidal temples of Chaldæa are not less remarkable for the labour bestowed on them, and far surpass the buildings of Assyria in the excellence of their brickwork.

The practice of building great pyramidal temples seems to have passed eastwards to India and Burmah, where it appears in buildings of a later date, in Buddhist topes and pagodas; marvels of skill in masonry, and far surpassing the old brick mounds of Chaldæa in richness of design and in workmanship. Even so late as this century a king of Burmah began to build a brick temple of the old type, the largest building, according to Fergusson, which has been attempted since the Pyramids.[1]

The mere magnitude of many of these works is not so wonderful when we take into account the abundance of labour which those rulers could command. Countries were depopulated, and their inhabitants carried off and made to labour for the conquerors. The inscriptions of Assyria describe minutely the spoils of war and the number of captives; and in Egypt we have frequent mention made of works being executed by the labour of captive peoples. Herodotus tells us that as many as 360,000 men were employed in building one palace for Sennacherib.[2] At the same time it must not be forgotten that the very character of the multitude would demand from some one the skill and brain to organise and direct, to design and plan the work.

It would be surprising if men who were capable of undertaking and successfully completing unproductive works of such magnitude did not also employ their powers on works of a more useful class. Traces still remain of such works; enough to show, when compared with the scanty records of the times which have come down to us, that the prosperity of such countries as Egypt and Mesopotamia was not wholly dependent on war and conquest, but that the reverse was more likely the case, and that the natural capabilities of those countries were greatly enlarged by the construction of useful works of such magnitude as to equal, if not in some cases surpass, those of modern times.

Egypt was probably far better irrigated in the days of the Pharaohs than it is now. To those unacquainted with the difficulties which must be met with and overcome before a successful system of irrigation can be carried out, even in countries in which the physical conditions are favourable, it may appear that nothing more is required than an adequate supply of unskilled labour. Far more than this was required: the Egyptians had some knowledge of surveying, for Eustathius says they recorded their marches on maps;[3] but such knowledge was probably in those days very limited, and it required no ordinary grasp of mind to see the utility of such extensive works as were carried out in Egypt and Mesopotamia, and, having seen the utility, to successfully design and execute them. To cite one in Egypt—Lake Mœris, of which the remains have been explored by M. Linant, was a reservoir made by one of the Pharaohs, and supplied by the flood waters of the Nile. It was 150 square miles in extent, and was retained by a bank or dam 60 yards wide and 10 high, which can be traced for a distance of thirteen miles. This reservoir was capable of irrigating 1,200 square miles of country.[4] No work of this class has been undertaken on so vast a scale since, even in these days of great works.

The prosperity of Egypt was in so great a measure dependent on its great river, that we should expect that the Egyptians, a people so advanced in art and science, would at an early period have made themselves acquainted with its *régime*. We know that they carefully registered the height of the annual rise of its waters; such registers still remain inscribed on the rocks on the banks of the Nile, with the name of the king in whose reign they were made.[5] The people of Mesopotamia were equally observant of the *régime* of their great rivers, and took advantage in designing their canals of the different periods in the rising of the waters of the Tigris and Euphrates. A special officer was appointed in Babylon, whose duty it was to measure the rise of the river; and he is mentioned in an inscription found in the ruins of that city, as recording the height of the water in the temple of Bel.[6] The Assyrians, who had a far more difficult country to deal with, owing to its rocky and uneven surface, showed even greater skill than the Babylonians in forming their canals, tunnelling through rock, and building dams of masonry across the Euphrates. While the greater number of these canals in Egypt and Mesopotamia were made for the purpose of irrigation, others seem to have been made to serve at the same time for navigation. Such was the canal which effected a junction between the Mediterranean and the Red Sea, which was a remarkable work, having regard to the requirements of the age in which it was made. Its length was about eighty miles; its width admitted of two triremes passing one another.[1] At least one of the navigable canals of Babylonia, attributed to Nebuchadnezzar, can compare in extent with any work of later times. I believe Sir H. Rawlinson has traced the canal to which I allude throughout the greater part of its course, from Hit on the Euphrates to the Persian Gulf, a distance of between four and five hundred miles.[2] It is a proof of the estimation in which such works were held in Babylonia and Assyria, that, among the titles of the god Vul were those of "Lord of Canals," and "The Establisher of Irrigation Works."[3]

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[1] Hunter's "Orissa," vol. i. p. 298.
[2] Strabo. bk. iii. c. ii. § 10.
[3] Percy's "Iron and Steel," p. 882.
[4] Layard's "Nineveh and Babylon," p. 589.

[1] Fergusson's "History of Architecture," vol. ii. p. 523.
[2] Rawlinson's "Herodotus," vol. i. p. 319, 2nd edit.
[3] Ibid. vol. ii p. 278, 2nd edit.
[4] M. Linant's "Mémoire sur le lac Mœris."
[5] Lepsius' "Discoveries in Egypt, &c.," p. 268.
[6] Smith's "Assyrian Discoveries," pp 395–7, 2nd edit.

The springs of knowledge which had flowed so long in Babylonia and Assyria were dried up at an early period. With the fall of Babylon and destruction of Nineveh the settled population of the fertile plains around them disappeared, and that which was desert before man led the waters over it became desert again, affording a wide field for, and one well worthy of, the labours of engineers to come.

Such was not the case with Egypt. Long after the period of its greatest prosperity was reached, it remained the fountain head from whence knowledge flowed to Greece and Rome. The philosophers of Greece and those who, like Archimedes, were possessed of the best mechanical knowledge of the time, repaired to Egypt to study and obtain the foundation of their knowledge from thence.

Much as Greece and Rome were indebted to Egypt, it will probably be found, as the inscribed tablets met with in the mounds of Assyria and Chaldæa are deciphered, that the later civilisations owe, if not more, at least as much, to those countries as to Egypt. This is the opinion of Mr. Smith, who, in his work describing his recent interesting discoveries in the East, says that the classical nations "borrowed far more from the valley of the Euphrates than that of the Nile."[4]

In the science of astronomy, which in these days is making such marvellous discoveries, Chaldæa was undoubtedly pre-eminent. Among the many relics of these ancient peoples which Mr. Smith has recently brought to this country is a portion of a metal astrolabe from the palace of Sennacherib, and a tablet on which is recorded the division of the heavens according to the four seasons, and the rule for regulating the intercalary month of the year. Not only did the Chaldæans map out the heavens and arrange the stars, but they traced the motion of the planets, and observed the appearance of comets; they fixed the signs of the zodiac, and they studied the sun and moon and the periods of eclipses.[5]

But to return to that branch of knowledge to which I wish more particularly to draw your attention, as it grew and spread from east to west, from Asia over Europe. Of all nations of Europe the Greeks were most intimately connected with the civilisation of the East. A maritime people by the nature of the land they lived in, colonisation followed as a matter of course on the tracks of their trading vessels; and thus, more than any other people, they helped to spread Eastern knowledge along the shores of the Mediterranean, and throughout the south of Europe.

The early constructive works of Greece, till about the seventh century B.C., form a strong contrast to those of its more prosperous days. Commonly called Pelasgian, they are more remarkable as engineering works than admirable as those which followed them were for architectural beauty. Walls of huge unshapely stones—admirably fitted together, however—tunnels, and bridges, characterise this period. In Greece, during the few and glorious centuries which followed, the one aim in all construction was to please the eye, to gratify the sense of beauty; and in no age was that aim more thoroughly and satisfactorily attained.

In these days, when sanitary questions attract each year more attention, we may call to mind that twenty-three centuries ago the city of Agrigentum possessed a system of sewers, which, on account of their large size, were thought worthy of mention by Diodorus.[6] This is not, however, the first record of towns being drained; the well-known Cloaca Maxima, which formed part of the drainage system of Rome, was built some two centuries earlier, and great vaulted drains passed beneath the palace mounds of unburnt brick at Nimroud and Babylon; and possibly we owe the preservation of many of the interesting remains found in the brick mounds of Chaldæa to the very elaborate system of pipe drainage discovered in them, and described by Loftus.[1]

Whilst Pelasgian art was being superseded in Greece, the city of Rome was founded in the eighth century before our era; and Etruscan art in Italy, like the Pelasgian art in Greece, was slowly merged in that of an Aryan race. The Etruscans, like the Pelasgians and the old Egyptians, were Turanians, and remarkable for their purely constructive or engineering works. Their city walls far surpass those of any other ancient race, and their drainage works and tunnels are most remarkable.

The only age which can compare with the present one in the rapid extension of utilitarian works over the face of the civilised world, is that during which the Romans, an Aryan race, as we are, were in power. As Fergusson has said, the mission of the Aryan races appears to be to pervade the world with useful and industrial arts. That the Romans adorned their bridges, their aqueducts, and their roads; that with a sound knowledge of construction they frequently made it subservient to decoration, was partly owing to the mixture of Etruscan or Turanian blood in their veins, and partly to their great wealth, which made them disregard cost in their construction, and to their love of display.

It would be impossible for me to do justice to even a small part of the engineering works which have survived fourteen centuries of strife, and remain to this day as monuments of the skill, the energy, and ability of the great Roman people. Fortunately, their works are more accessible than those of which I have spoken hitherto, and many of you are probably already familiar with them.

Conquerors of the greater part of the civilised world, the admirable organisation of the Romans enabled them to make good use of the unbounded resources which were at their disposal. Yet, while the capital was enriched, the development of the resources of the most distant provinces of the empire was never neglected.

War, with all its attendant evils, has often indirectly benefited mankind. In the long sieges which took place during the old wars of Greece and Rome, the inventive power of man was taxed to the utmost to provide machines for attack and defence. The ablest mathematicians and philosophers were pressed into the service, and helped to turn the scale in favour of their employers. The world has to regret the loss of more than one, who, like Archimedes, fell slain by the soldiery while applying the best scientific knowledge of the day to devising means of defence during the siege.[2] In these days, too, science owes much to the labours of engineers and able men, whose time is spent in making and improving guns, the materials composing them, and armour plates to resist them, or in studying the motion of ships of war in a seaway.

The necessity for roads and bridges for military purposes has led to their being made where the necessary stimulus from other causes was wanting; and so means of communication, and the interchange of commodities, so essential to the prosperity of any community, have thus been provided. Such was the case under the Roman Empire. So, too, in later times the ambition of Napoleon covered France and the countries subject to her with an admirable system of military roads. At the same time, we must do Napoleon the justice of saying that his genius and foresight gave a great impetus to the construction of all works favourable to commercial progress. So, again, in this country it was the rebellion of 1745, and the want felt of roads for military purposes, which first led to the construction of a system of roads in it unequalled since the time of the Roman occupation. And lastly, in India, in Germany, and in Russia, more than one example could be pointed out where industry will benefit by railways which have originated in military precautions rather than in commercial requirements.

But to return to Rome. Roads followed the tracks of her legions into the most distant provinces of the empire. Three hundred and seventy-two great roads are enumerated, together more than 48,000 miles in length, according to the itinerary of Antoninus.

The water supply of Rome during the first century of our era would suffice for a population of seven millions, supplied at the rate at which the present population of London is supplied. This water was conveyed to Rome by nine aqueducts; and in later years the supply was increased by the construction of five more aqueducts. Three of the old aqueducts have sufficed to supply the wants of the city in modern times. These aqueducts of Rome are to be numbered among her grandest engineering works.[1] Time will not admit of my saying anything about her harbour works and bridges, her basilicas and baths, and numerous other works in Europe, in Asia, and in Africa. Not only were these works executed in a substantial and perfect manner, but they were maintained by an efficient staff of men divided into bodies, each having their special duties to perform. The highest officers of state superintended the construction of works, were proud to have their names associated with them, and constructed extensive works at their own expense.

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[1] Herodotus, bk ii. c. clviii.

[2] Rawlinson's "Herodotus," vol. i. p. 420, 2nd edit.

[3] Ibid. p. 498.

[4] Smith's (G.) "Assyrian Discoveries," p. 451, 2nd edit.

[5] Ibid.

[6] Agrigentum was a celebrated Greek city, founded B.C. 582, population 200,000 (*Diodorus*, 406 B.C.), drained by Phœax, who lived B.C. 480.

[1] Rawlinson's "Five Ancient Monarchies," vol. i. pp. 89, 90, 2nd edit.

[2] Archimedes, B.C. 287-212; killed at the siege of Syracuse by the Roman soldiers.

Progress in Europe stopped with the fall of the Roman Empire. In the fourth and succeeding centuries the barbarian hordes of Western Asia, people who felt no want of roads and bridges, swept over Europe to plunder and destroy.

With the seventh century began the rise of the Mohammedan power, and a partial return to conditions apparently more favourable to the progress of industrial art, when widespread lands were again united under the sway of powerful rulers.[2] Science owes much to Arab scholars, who kept and handed on to us the knowledge acquired so slowly in ancient times, and much of which would have been lost but for them. Still, few useful works remain to mark the supremacy of the Mohammedan power at all comparable to those of the age which preceded its rise.

A great building age began in Europe in the tenth century, and lasted through the thirteenth. It was during this period that these great ecclesiastical buildings were erected, which are not more remarkable for artistic excellence than for boldness in design.

While the building of cathedrals progressed on all sides in Europe, works of a utilitarian character, which concern the engineer, did not receive such encouragement, excepting perhaps in Italy.

From the twelfth to the thirteenth centuries, with the revival of the arts and sciences in the Italian republics, many important works were undertaken for the improvement of the rivers and harbours of Italy. In 1481 canal locks were first used; and some of the earliest of which we have record were erected by Leonardo da Vinci, who would be remembered as a skilful engineer had he not left other greater and more attractive works to claim the homage of posterity.

The great use that has since been made of this simple means of transferring floating vessels from one water level to another, in connection not only with inland navigation, but in all the great ports and harbours of the world, renders it all the more deserving of remark.

In India, under the Moguls, irrigation works, for which they had a natural aptitude, were carried on during these centuries with vigour, and more than one emperor is noted for the numerous great works of this nature which he carried out. If the native records can be trusted, the number of hydraulic works undertaken by some rulers is surprising. Tradition relates that one king who reigned in Orissa in the twelfth century made one million tanks or reservoirs, besides building sixty temples, and erecting numerous other works.[3]

In India, the frequent overflow of the great rivers, and the periodical droughts, which rendered irrigation necessary, led to extensive protective works being undertaken at an early period; but as these works have been maintained by successive rulers, Mogul and Mohammedan, until recent times, and have not been left for our inspection, deserted and useless for 3,000 years or more, as is often the case in Egypt and Mesopotamia, there is more difficulty in ascertaining the date of such works in India.

Works of irrigation were among the earliest attempts at engineering undertaken by the least civilised inhabitants in all parts of the world. Even in Australia, where savages are found as low as any in the scale of civilisation, traces of irrigation works have been found; these works, however, must be taken to show that the natives were once somewhat more civilised than we now find them. In Feejee, our new possession, the natives occasionally irrigate their land,[4] and have executed a work of a higher class, a canal some two miles long and sixty feet wide, to shorten the distance passed over by their canoes.[1] The natives of New Caledonia irrigate their fields with great skill.[2] In Peru, the Incas excelled in irrigation as in other great and useful works, and constructed most admirable underground conduits of masonry for the purpose of increasing the fertility of the land.[3]

It is frequently easier to lead water where it is wanted than to check its irruption into places where its presence is an evil, often a disaster. For centuries the existence of a large part of Holland has been dependent on the skill of man. How soon he began in that country to contest with the sea the possession of the land we do not know, but early in the twelfth century dykes were constructed to keep back the ocean. As the prosperity of the country increased with the great extension of its commerce, and land became more valuable and necessary for an increasing population, very extensive works were undertaken. Land was reclaimed from the sea, canals were cut, and machines were designed for lifting water. To the practical knowledge acquired by the Dutch, whose method of carrying out hydraulic works is original and of native growth, much of the knowledge of the present day in embanking, and draining, and canal making is due. The North Holland Canal[4] was the largest navigable canal in existence until the Suez Canal was completed; and the Dutch have just now nearly finished making a sea canal from Amsterdam to the North Sea, which, though not equal to the Suez Canal in length, will be as great in width and depth, and involves perhaps larger and more important works of art. This country was for many years beholden to the Dutch for help in carrying out hydraulic works. In the seventeenth century much fen land in the eastern counties was drained by Dutch labour, directed by Dutch engineers, among whom Sir Cornelius Vermuyden, an old campaigner of the Thirty Years' War, and a colonel of horse under Cromwell, is the most noted.

While the Dutch were acquiring practical knowledge in dealing with water, and we in Britain among others were benefiting by their experience, the disastrous results which ensued from the inundations caused by the Italian rivers of the Alps gave a new importance to the science of hydraulics. Some of the greatest philosophers of the seventeenth century—among them Torricelli, a pupil of Galileo,[5]—were called upon to advise and to superintend engineering works; nor did they confine themselves to the construction of preventive works, but thoroughly investigated the condition pertaining to fluids at rest or in motion, and gave to the world a valuable series of works on hydraulics and hydraulic engineering, which form the basis of our knowledge of these subjects at the present day.

Some of the best scientific works (prior to the nineteenth century) on engineering subjects we owe to Italian and French writers. The writings of Belidor, an officer of artillery in France in the seventeenth century, who did not, however, confine himself to military subjects, drew attention to engineering questions. Not long after their appearance, the Ponts et Chaussées[6] were established, which has maintained ever since a body of able men specially educated for, and devoted to, the prosecution of industrial works.

The impulse given to road-making in the early part of the last century soon extended to canals and means for facilitating locomotion and transport generally. Tramways were used in connection with mines at least as early as the middle of the seventeenth century, but the rails were, in those days, of wood. The first iron rails are said to have been laid in this country as early as 1738; after which time their use was gradually extended, until it became general in mining districts.

By the beginning of this century the great ports of England were connected by a system of canals; and new harbour works became necessary, and were provided to accommodate the increase of commerce and trade, which improved means of internal transport had rendered possible. It was in the construction of these works that our own Brindley and Smeaton, Telford and Rennie, and other engineers of their time, did so much.

But it was not until the steam-engine, improved and almost created by the illustrious Watt, became such a potent instrument, that engineering works to the extent they have since been carried out became possible or necessary. It gave mankind no new faculty, but it at once set his other faculties on an eminence, from which the extent of his future operations became almost unlimited.

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[1] Total length 250 miles; 50 on arches, 200 underground.

[2] "Under the last of the house of Ommiyah (750 A.D.) one command was obeyed almost along the whole diameter of the known world, from the banks of the Sihon to the utmost promontory of Portugal."—Hallam's "Middle Ages," vol. ii. p. 120, 2nd edit.

[3] King Bhim Deo. A.D. 1174, 60 temples, 10 bridges, 40 wells stone cased, 152 landing stairs, and 1,000,000 tanks.—Hunter's "Orissa," vol. i. p. 100.

[4] Erskine's "Western Pacific," p. 171.

[1] Seeman, p. 82.

[2] Erskine's "Western Pacific," p. 355.

[3] Markham's "Cieza" (note), p, 236.

[4] North Holland Canal, finished in 1825.

[5] Galileo, b. 1564; Torricelli, b. 1608.

[6] Ponts et Chaussées, established 1720.

Water-mills, wind-mills, and horse-machines were in most cases superseded. Deep mines, before only accessible by adits and water levels, could at once be reached with ease and economy. Lakes and fens which, but for the steam-engine, would have been left untouched, were drained and cultivated.

The slow and laborious toil of hands and fingers, bone and sinew, was turned to other employments, where, aided by ingenious mechanical contrivances, the produce of one pair of hands was multiplied a thousand-fold, and their cunning extended until results marvellous, if you consider them, were attained. Since the time of Watt the steam-engine has exerted a power, made conquests, and increased and multiplied the material interests of this globe to an extent which it is scarcely possible to realise.

But while Watt has gained a world-wide, well-earned fame, the names of those men who have provided the machines to utilise the energies of the steam-engine are too often forgotten. Of their inventions the majority of mankind know little. They worked silently at home, in the mill, or in the factory, observed by few. Indeed, in most cases these silent workers had no wish to expose their work to public gaze. Were it not so, the factory and the mill are not places where people go to take the air. How long in the silent night the inventors of these machines sat and pondered; how often they had to cast aside some long-sought mechanical movement and seek another and a better arrangement of parts, none but themselves could ever know. They were unseen workers, who succeeded by rare genius, long patience, and indomitable perseverance.

More ingenuity and creative mechanical genius is perhaps displayed in machines used for the manufacture of textile fabrics than by those used in any other industry. It was not until late in historical times that the manufacture of such fabrics became established on a large scale in Europe. Although in China man was clothed in silk long ago, and although Confucius, in a work written 2,300 years ago, orders with the greatest minuteness the rules to be observed in the production and manufacture of silk, yet it was worth nearly its weight in gold in Europe in the time of Aurelian, whose empress had to forego the luxury of a silk gown on account of its cost?[1] Through Constantinople and Italy the manufacture passed slowly westwards, and was not established in France until the sixteenth century, and arrived at a still later period in this country. It is related that James V. had to borrow a pair of silk hose from the Earl of Mar, in order that he might not, as he expressed it, appear as a scrub before strangers.

So cotton, of which the manufacture in India dates from before historical times, had scarcely by the Christian era reached Persia and Egypt. Spain in the tenth and Italy in the fourteenth century manufactured it, but Manchester, which is now the great metropolis of the trade, not until the latter half of the seventeenth century.

Linen was worn by the old Egyptians, and some of their linen mummy cloths surpass in fineness any linen fabrics made in later days.[2] The Babylonians wore linen also and wool, and obtained a widespread fame for skill in workmanship and beauty in design.

In this country wool once formed the staple for clothing. Silk was the first rival, but its costliness placed it beyond the reach of the many. To introduce a new material or improved machine into this or other countries a century or more ago was no light undertaking. Inventors, and would-be benefactors alike, ran the risk of loss of life. Loud was the outcry made in the early part of the eighteenth century against the introduction of Indian cottons and Dutch calicoes.

Until 1738, in which year the improvements in spinning machinery were begun, each thread of worsted or cotton wool had been spun between the fingers in this and all other countries. Wyatt, in 1738, invented spinning by rollers instead of fingers, and his invention was further improved by Arkwright. In 1770 Hargreaves patented the spinning jenny, and Crompton the mule in 1775, a machine which combined the advantages of the frames of both Hargreaves and Arkwright. In less than a century after the first invention by Wyatt, double mules were working in Manchester with over 2,000 spindles. Improvements in machines for weaving were begun at an earlier date. In 1579 a ribbon loom is said to have been invented at Dantzic, by which from four to six pieces could be woven at one time, but the machine was destroyed and the inventor lost his life.[1] In 1800 Jacquard's most ingenious invention was brought into use, which, by a simple mechanical operation, determines the movements of the threads which form the pattern in weaving. But the greatest discovery in the art of weaving was wrought by Cartwright's discovery of the power loom, which led eventually to the substitution of steam for manual labour, and enabled a boy with a steam loom to do fifteen times the work of a man with a hand loom.

For complex ingenuity few machines will compare with those used in the manufacture of lace and bobbin net. Hammond, in 1768, attempted to adapt the stocking frame to this manufacture, which had hitherto been conducted by hand. It remained for John Heathcoat to complete the adaptation in 1809, and to revolutionise this branch of industry, reducing the cost of its produce to one-fortieth of what the cost had been before Heathcoat's improvements were effected.

Most of these ingenious machines were in use before Watt's genius gave the world a new motive power in the steam-engine; and, had the steam-engine never been perfected, they would still have enormously increased the productive power of mankind. Water power was applied to many of them; in the first silk-thread mill erected at Derby in 1738, 318 million yards of silk thread were spun daily with one water-wheel.

These are happier times for inventors: keen competition among manufacturers does not let a good invention lie idle now. That which was rejected by old machines as waste is now worked up into useful fabrics by new ones. From all parts of the world new products come—jute from India, flax from New Zealand, and many others which demand new adaptations of old machines or new and untried mechanical arrangements to utilise them. Time would fail me if I were to attempt to enumerate one tithe of these rare combinations of mechanical skill; and, indeed, no one will ever appreciate the labour and supreme mental effort required for their construction who has not himself seen them and their wondrous achievements.

Steamboats, the electric telegraph, and railways, are more within the cognisance of the world at large, and the progress that has been made in them in little more than one generation is better known and appreciated.

It is not more than forty years since one of our scientific men, and an able one too, declared at a meeting of this Association that no steamboat would ever cross the Atlantic; founding his statement on the impracticability, in his view, of a steamboat carrying sufficient coal, profitably, I presume, for the voyage. Yet, soon after this statement was made, the *Sirius* steamed from Bristol to New York in seventeen days,[2] and was soon followed by the *Great Western*, which made the homeward pasage in thirteen-and-a-half days; and with these voyages the era of steamboats began. Like most important inventions, that of the steamboat was a long time in assuming a form capable of being profitably utilised; and even when it had assumed such a form, the objections of commercial and scientific men had still to be overcome.

Among the many names connected with the early progress in the construction of steamboats, perhaps none is more worthy of remembrance than that of Patrick Miller, who, with the assistance of Symington, an engineer, and Taylor, who, was his children's tutor, constructed a small steamboat. Shortly afterwards Lord Dundas, who saw the value of the application of steam for the propulsion of boats, had the first really practical steamboat constructed with a view to using it on the Forth and Clyde Canal. The proprietors, however, objected, and the boat lay idle. Again another attempt to make practical use of the steamboat failed through the death of the Duke of Bridgewater, who, with his characteristic foresight, had seen the value of steam as a motive power for boats, and had determined to introduce steamboats on the canal which bears his name.

The increase in the number of steamboats since the time when the *Sirius* first crossed the Atlantic has been very great. Whereas in 1814 the United Kingdom only possessed two steam vessels, of together 456 tons burden, in 1872 there were on the register of the United Kingdom 3,662 steam vessels, of which the registered tonnage amounted to over a million and a half of tons,[3] or to nearly half the whole steam tonnage of the world, which did not at that time greatly exceed three million tons.

As the number of steamboats has largely increased, so also gradually has their size increased until it culminated in the hands of Brunel in the *Great Eastern.*

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[1] Manufacture of silk brought from China to Constantinople A.D. 522.
Wilkinson's "Ancient Egyptians;" Pliny, bk. xix. c. ii.

[1] Beckman's "History of Inventions," vol. ii. p. 528.

[2] First steamer crossed the Atlantic by steam alone in 1838.

[3] Board of Trade Return, 15th of July, 1874, Table 8.

A triumph of engineering skill in ship-building, the *Great Eastern* has not been commercially so successful. In this, as in many other engineering problems, the question is not how large a thing can be made, but how large, having regard to other circumstances, it is proper at the time to make it.

If, as regards the dimensions of steamboats, we have at present somewhat overstepped the limits in the *Great Eastern*, much still remains to be done in perfecting the form of vessels, whether propelled by steam or driven by the force of the wind. A distinguished member of this Association, Mr. Froude, has now for some years devoted himself to investigations carried on with a view to ascertain the form of vessel which will offer the least resistance to the water through which it must pass. So many of us in these days are called upon to make journeys by sea as well as by land, that we can well appreciate the value of Mr. Froude's labours, so far as they tend to curtail the time which we must spend on our ocean journeys; and we should all feel grateful to him if from another branch of his investigations, which relates to the rolling of ships, it should result that the movement in passenger vessels could be reduced. A gallant attempt in this direction has lately been made by Mr. Bessemer; whether a successful one yet remains to be proved. In any event, he and those who have acted with him deserve our praise for an experiment which must add to our knowledge.

It is a question of vital importance to the steamboat that the consumption of fuel should be reduced to the smallest possible amount, inasmuch as each ton of fuel excludes a ton of cargo.

As improvements in the form of the hull are effected, less power—that is, less fuel—will be required to propel the vessel through the water for a given distance. Great as have been the improvements effected in marine engines to this end, much still remains to be done. Wolf's compound engine, so long overlooked, is, with some improvements, being at last applied. Whereas the consumption of fuel in such vessels as the *Himalaya* used to be from 5 to 6 lbs. of fuel per effective horse-power, it has been reduced, by working steam more expansively in vessels of a later date, to 2 lbs. Yet, comparing this with the total amount of energy of 2 lbs. of coal, it will be found that not a tenth part of the power is obtained which that amount of coal would theoretically call into action.[1]

We live in an age when great discoveries are made, and when they are speedily taken advantage of if they are likely to be of service to mankind.

In former times man's inventions were frequently in advance of the age, and they were laid aside to await a happier era. There were in those earlier days too few persons who cared to, or who could, avail themselves of the proffered boon, and there was no sufficient accumulation of wealth to justify its being appropriated to schemes which are always in their early stage more or less speculative.

There is no more remarkable instance of the rapid utilisation of what was in the first instance regarded by most men as a mere scientific idea, than the adoption and extension of the electric telegraph.

Those who read Odier's letter written in 1773, in which he made known his idea of a telegraph which would enable the inhabitants of Europe to converse with the Emperor of Mogul, little thought that in less than a century a conversation between persons at points so far distant would be possible. Still less did those who saw in the following year messages sent from one room to another by Lesage in the presence of Friedrich of Prussia, realise that they had before them the germ of one of the most extraordinary inventions among the many that will render this century famous.

I should weary you were I to follow the slow steps by which the electric telegraph of to-day was brought to its present state of efficiency. In the present century few years have passed without new workers appearing in the field; some whose object was to utilise the new-found power for the benefit of mankind, others—and their work was not the least important in the end—whose object was to investigate magnetism and electrical phenomena as presenting scientific problems still unsolved. Galvani, Volta, Oersted, Arago, Sturgeon, and Faraday, by their labours, helped to make known the elements which rendered it possible to construct the electric telegraph. With the battery, the electric coil, and the electro-magnet, the elements were complete, and it only remained for Sir Charles Wheatstone and others to combine them in a useful and practically valuable form. The inventions of Alexander, Steinheil, and those of similar nature to that of Sir Charles Wheatstone, were made known at a later date in the same year, which will ever be memorable in the annals of telegraphy.[1]

The first useful telegraph was constructed upon the Blackwall Railway in 1838, Messrs. Wheatstone's and Cooke's instruments being employed. From that time to this the progress of the electric telegraph has been so rapid, that at the present time, including land lines and submarine cables, there are in use in different parts of the world not less than 400,000 miles of telegraph.

Among the numerous inventions of late years, the automatic telegraph of Mr. Alexander Bain, of Dr. Werner Siemens, and of Sir Charles Wheatstone, are especially worthy of notice. Mr. Bain's machine is chiefly used in the United States, that of Dr. Werner Siemens in Germany. In this country the machine invented by Sir Charles Wheatstone, to whom telegraphy owes so much, is chiefly employed. By his machine, after the message has been punched out in a paper ribbon by one machine on a system analogous to the dot and dash of Morse, the sequence of the currents requisite to transmit the message along the wire is automatically determined in a second machine by this perforated ribbon. This second operation is analogous to that by which in Jacquard's loom the motions of the threads requisite to produce the pattern is determined by perforated cards. By Wheatstone's machine errors inseparable from manual labour are avoided; and what is of even more importance in a commercial point of view, the time during which the wire is occupied in the transmission of a message is considerably diminished.

By the application of these automatic systems to telegraphy, the speed of transmission has been wonderfully accelerated, being equal to 200 words a minute, that is, faster than a shorthand writer can transcribe; and, in fact, words can now be passed along the wires of land lines with a velocity greater than can be dealt with by the human agency at either end.

Owing partly to the retarding effects of induction and other causes, the speed of transmission by long submarine cables is much smaller. With the cable of 1858 only 2½ words per minute were got through. The average with the Atlantic cable, Dr. C. W. Siemens informs me, is now seventeen words, but twenty-four words per minute can be read.

One of the most striking phenomena in telegraphy is that known as the duplex system, which enables messages to be sent from each end of the same wire at the same time. This simultaneous transmission from both ends of a wire was proposed in the early days of telegraphy, but, owing to imperfect insulation, was not then found to be practicable; but since then telegraphic wires have been better insulated, and the system is now becoming of great utility, as it nearly doubles the capacity for work of every wire.

And yet within how short a period of time has all the wonderful progress in telegraphy been achieved! How incredulous the world a few years ago would have been if then told of the marvels which in so short a space of time were to be accomplished by its agency!

It is not long ago—1823—that Mr. (now Sir Francis) Ronald, one of the early pioneers in this field of science, published a description of an electric telegraph. He communicated his views to Lord Melville, and that nobleman was obliging enough to reply that the subject should be inquired into; but before the nature of Sir Francis Ronald's suggestions could be known,

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[1] Theoretical Energy of 1 lb. of Coal:—

The proportions of heat expended in generating saturated steam at 212° Fahr., and at 14·7 lbs. pressure per square inch, from water at 212° are:—

	Units of heat.	Mechanical equivalent in foot lbs.
I. In the formation of steam	892·8	689,242
II. In resisting the incumbent pressure of 14·7 lbs. per square inch ...	72·3	55,815
	965.1	745,057

One pound of Welsh coal will theoretically evaporate 15 lbs. of water at 212° to steam at 212°. Therefore, the full theoretical value of the combustion of 2 lbs. of Welsh coal is—

$$2 \times 15 \times 745{,}057 \text{ foot pounds,}$$

or,

$$\frac{2 \times 15 \times 745{,}057}{60 \times 33{,}000} \text{ horse-power, if consumed in 1 hour.}$$

$$= 11{\cdot}2 \text{ horse-power.}$$

As the consumption of coal per effective horse-power in a marine engine is 2 lbs., the power obtained is to the whole theoretical power as 1 is to 11.

[1] Dates of patents: Wheatstone, March 1, 1837; Alexander, April 22, 1837; Steinheil, July 1, 1837; Morse, October 1837.

except to a few, that gentleman received a reply from Mr. Barrow, "that telegraphs of any kind were then wholly unnecessary, and that no other than the one then in use would be adopted;" the one then in use being the old semaphore, which, crowning the tops of hills between London and Portsmouth, seemed perfection to the Admiralty of that day.

I am acquainted with some who, when the first Transatlantic cable was proposed, contributed towards that undertaking with the consciousness that it was only an experiment, and that subscribing to it was much the same thing as throwing their money into the sea. Much of this cable was lost in the first attempt to lay it; but its promoters, nothing daunted, made 900 miles more cable, and finally laid it successfully in the following year, 1858.

The telegraphic system of the world comprises almost a complete girdle round the earth; and it is probable that the missing link will be supplied by a cable between San Francisco in California and Yokohama in Japan.

How resolute and courageous those who engaged in submarine telegraphy have been will appear from the fact that, though we have now 50,000 miles of cable in use, to get at this result nearly 70,000 miles were constructed and laid. This large percentage of failure, in the opinion of Dr. C. W. Siemens (to whom I am much indebted for information on this subject), was partly due to the late introduction of testing a cable under water before it is laid, and to the use of too light iron sheathing.

Of immense importance in connection with the subsequent extension of submarine cables have been the discoveries of Ohm and Sir William Thomson, and the knowledge obtained that the resistance in wire of homogeneous metal is directly proportional to the length, so that the place of a fault in a cable of many thousand miles in length can be ascertained with so much precision as to enable you to go at once to repair it, although the damaged cable may lie in some thousands of fathoms of water.

Of railways the progress has been enormous, but I do not know that in a scientific point of view a railway is so marvellous in its character as the electric telegraph. The results, however, of the construction and use of railways are more extensive and widespread, and their utility and convenience brought home to a larger portion of mankind. It has come to pass, therefore, that the name of George Stephenson has been placed second only to that of James Watt; and as men are and will be estimated by the advantages which their labours confer on mankind, he will remain in that niche, unless indeed some greater luminary should arise to outshine him. The merit of George Stephenson consisted, among other things, in this, that he saw more clearly than any other engineer of his time the sort of thing that the world wanted, and that he persevered in despite of learned objectors with the firm conviction that he was right and they were wrong, and that there was within himself the power to demonstrate the accuracy of his convictions.

Railways are a subject on which I may (I hope without tiring you) speak somewhat more at length. The British Association is peripatetic, and without railways its meetings, if held at all, would, I fear, be greatly reduced in numbers. Moreover, you have all an interest in them: you all demand to be carried safely, and you insist on being carried fast. Besides, everybody understands, or thinks he understands, a railway, and therefore I shall be speaking on a subject common to all of us, and shall possibly only put before you ideas which others as well as myself have already entertained.

We who live in these days of roads and railways, and can move with a fair degree of comfort, speed, and safety, almost where we will, can scarcely realise the state of England two centuries ago, when the years of opposition which preceded the era of coaches began; when, as in 1662, there were but six stages in all England, and John Crossdell, of the Charterhouse, thought there were six too many; when Sir Henry Herbert, a member of the House of Commons, could say, "If a man were to propose to carry us regularly to Edinburgh in coaches in seven days, and bring us back in seven more, should we not vote him to Bedlam?"

In spite of short-sighted opposition, coaches made their way; but it was not till a century later, in 1784—and then I believe it was in this city of Bristol—that coaches were first established for the conveyance of mails. Those here who have experienced, as I have, what the discomforts were of long journeys inside the old coaches, will agree with me that they were very great; and I believe, if returns could be obtained of the accidents which happened to coaches, it would be found that many more people were injured and killed in proportion to the number that travelled by that mode than by the railways of to-day.

No sooner had our ancestors settled down with what comfort was possible in their coaches, well satisfied that twelve miles an hour was the maximum speed to be obtained or that was desirable, than they were told that steam conveyance on iron railways would supersede their "present pitiful" methods of conveyance. Such was the opinion of Thomas Gray, the first promoter of railways, who published his work on a general iron railway in 1819. Gray was looked on as little better than a madman. "When Gray first proposed his great scheme to the public," said Chevalier Wilson, in a letter to Sir Robert Peel in 1845, "people were disposed to treat it as an effusion of insanity." I shall not enter on a history of the struggles which preceded the opening of the first railway. They were brought to a successful issue by the determination of a few able and far-seeing men. The names of Thomas Gray and Joseph Sandars, of William James and Edward Pease, should always be remembered in connection with the early history of railways, for it was they who first made the nation familiar with the idea. There is no fear that the name of Stephenson will be forgotten, whose practical genius made the realisation of the idea possible.

The Stockton and Darlington Railway was opened in 1825, the Liverpool and Manchester Railway in 1830, and in the short time which has since elapsed, railways have been extended to every quarter of the globe. No nation possessing wealth and population can afford to be without them; and though at present in different countries there is in the aggregate about 160,000 miles of railway, it is certain that in the course of a very few years this quantity, large as it is, will be very greatly exceeded.

Railways add enormously to the national wealth. More than twenty-five years ago it was proved to the satisfaction of a committee of the House of Commons, from facts and figures which I then adduced, that the Lancashire and Yorkshire Railway, of which I was the engineer, and which then formed the principal railway connection between the populous towns of Lancashire and Yorkshire, effected a saving to the public using the railway of more than the whole amount of the dividend which was received by the proprietors. These calculations were based solely on the amount of traffic carried by the railway, and on the difference between the railway rate of charge and the charges by the modes of conveyance anterior to railways. No credit whatever was taken for the saving of time, though in England preeminently time is money.

Considering that railway charges on many items have been considerably reduced since that day, it may be safely assumed that the railways in the British Islands now produce, or rather save to the nation, a much larger sum annually than the gross amount of all the dividends payable to the proprietors, without at all taking into account the benefit arising from the saving in time. The benefits under that head defy calculation, and cannot with any accuracy be put into money; but it would not be at all over-estimating this question to say that in time and money the nation gains at least what is equivalent to 10 per cent. on all the capital expended on railways. I do not urge this on the part of railway proprietors, for they did not embark in these undertakings with a view to the national gain, but for the expected profit to themselves. Yet it is as well it should be noted, for railway proprietors appear sometimes by some people to be regarded in the light of public enemies.

It follows from these facts that whenever a railway can be made at a cost to yield the ordinary interest of money, it is in the national interest that it should be made. Further, that though its cost might be such as to leave a smaller dividend than that to its proprietors, the loss of wealth to so small a section of the community will be more than supplemented by the national gain, and therefore there may be cases where a Government may wisely contribute in some form to undertakings which, without such aid, would fail to obtain the necessary support.

And so some countries, Russia for instance, to which improved means of transport are of vital importance, have wisely, in my opinion, caused lines to be made which, having regard to their own expenditure and receipts, would be unprofitable works, but in a national point of view are or speedily will be highly advantageous.

The Empire of Brazil, which I have lately visited, is arriving at the conclusion, which I think not an unwise one, that the State can afford, and will be benefited in the end, by guaranteeing 7 per cent. upon any railway that can of itself be shown to produce a net income of 4 per cent., on the assumption that the nation will be benefited at least to the extent of the difference.

A question more important probably in the eyes of many—safety of railway travelling—may not be inappropriate. At all events, it is well that the elements on which it depends should be clearly understood. It will be thought that longer experience in the management of railways should go to ensure greater safety, but there are other elements of the question which go to counteract this in some degree.

The safety of railway travelling depends on the perfection of the machine in all its parts, including the whole railway, with its movable plant, in that term; it depends also on the nature and quantity of traffic, and lastly, on human care and attention.

With regard to what is human, it may be said that so many of these accidents as arise from the fallibility of men will never be eliminated until the race be improved.

The liability to accident will also increase with the speed, and might be reduced by slackening that speed. It increases with the extent and variety of the traffic on the same line. The public, I fear, will rather run the risk than consent to be carried at a slower rate. The increase in extent and variety of traffic is not likely to receive any diminution; on the contrary, it is certain to augment.

I should be sorry to say that human care may not do something, and I am not among those who object to appeals through the press, and otherwise, to railway companies, though sometimes perhaps they may appear in an unreasonable form. I see no harm in men being urged in every way to do their utmost in a matter so vital to many.

A question may arise whether, if the railways were in the hands of the Government, they could not be worked with greater safety. Government would not pay their officers better, or perhaps so well, as the companies do, and it is doubtful whether they would succeed in attracting to the service abler men. They might do the work with a smaller number of chief officers, for much of the time of the companies' managers is occupied in internecine disputes. They might handle the traffic more despotically, diminishing the number of trains, or the accommodation afforded by them, or in other ways, to ensure more safety; but would the public bear any curtailment of convenience?

One thing they could, and perhaps would do. In cases where the traffic is varied, and could more safely be conducted with the aid of relief lines, which hold out no sufficient inducement to the companies to make, the Government, being content with a lower rate of interest, might undertake to make them, though then comes the question whether, when the whole of this vast machine came to depend for supplies on annual votes of Parliament, money would be forthcoming in greater abundance than it is under the present system.

But the consideration of this subject involves other and more difficult questions.

Where are the labours of Government to stop? The cares of State which cannot be avoided are already heavy and will grow heavier every year. Dockyard establishments are trifling to what the railway establishments, which already employ 250,000 men, would be. The assumption of all the railways would bring Government into conflict with every passenger, every trader, and every manufacturer. With the railway companies there would be no difficulty; they would sell their undertakings to anyone, provided the price was ample.

Looking at the vast growth of railway traffic, one measure occurs to me as conducive to the safety of railway passengers, and likely to be demanded some day; it is to construct between important places railways which should carry passengers only or coals only, or be set apart for some special separation of traffic; though there will be some difficulty in accomplishing this. Landowners, through whose properties such lines would pass, would probably wish to use such lines for general purposes. Nevertheless, it may have to be tried some day.

It would be instructive, were it practicable, to compare the relative proportion of accidents by railway and by the old stage-coaches, but no records that I am aware of exist of the latter that would enable such a comparison to be made. It is practicable to make some sort of comparison between the accidents in the earlier day of our own railways and the accidents occurring at a ater date

The Board of Trade have unfortunately abandoned the custom, which they adopted from 1852 to 1859, of returning the passenger mileage, which is given in the German returns, and is the proper basis upon which to found the proportion of accidents, and not on the number of passengers without any regard to distance travelled, which has altered very much, the average journey per passenger being nearly half in 1873 what it was in 1846.

It would be erroneous to compare the proportions of accidents to passengers carried in various years, even if the correct number of passengers travelling were given. But a figure is always omitted from the Board of Trade return, which makes the proportion of accidents to passengers appear larger than it is; this is the number of journeys performed by season-ticket holders. Some estimate could be made of the journeys of season-ticket holders by dividing the receipts by an estimated average fare, or the companies could make an approximate estimate, and the passenger mileage could be readily obtained by the railway companies from the tickets. These additions would greatly add to the value of the railway returns as statistical documents, and render the deductions made from them correct.

Though it has been a work of labour, I have endeavoured to supply these deficiencies, and I believe the results arrived at may be taken as fairly accurate.[1]

From the figures so arrived at, it appears the passenger mileage has doubled between 1861 and 1873; and at the rate of increase between 1870 and 1873 it would become double what it was in 1873 in twelve years from that time, namely in 1885.

The number of passengers has doubled between 1864 and 1873, and at the rate of increase between 1870 and 1873 it would become double what it was in 1873 in eleven-and-a-half years, or in 1885.

It must, however, be remembered that the rate of increase since 1870, though very regular for 1871, 1872, and 1873, is greater than in previous years, being probably due to the rise of wages and the great development of third-class traffic, and it would not be safe to assume this rate of increase will continue.

Supposing no improvement had been effected in the working of railway traffic, by the interlocking of points, the block system, &c., the increase of accidents should have borne some proportion to the passenger mileage, multiplied by the proportion between the train mileage and the length of line open, as the number of trains passing over the same line of rails would tend to multiply accidents in an increasing proportion, especially where the trains run at different speeds.

The number of accidents varies considerably from year to year, but taking two averages of ten years each, it appears that the proportion of deaths of passengers from causes beyond their control to passenger miles travelled in the ten years ending December 31, 1873, was only two-thirds of the same proportion in the ten years ending December 31, 1861; the proportion of all accidents to passengers from causes beyond their own control was one-ninth more in the last ten years than in the earlier, whereas the frequency of trains had increased on the average one-fourth.

The limit, however, of considerable improvements in signalling, increased brake power, &c., will probably be reached before long, and the increase of accidents will depend on the increase of traffic, together with the increased frequency of trains.

The large growth of railway traffic, which we may assume will double in twenty years, will evidently greatly tax the resources of the railway companies; and unless the present companies increase the number of the lines of way, as some have commenced to do, or new railways are made, the system of expeditious and safe railway travelling will be imperilled. Up to the present time, however, the improvements in regulating the traffic appear to have kept pace with the increase of traffic and of speed, as the slight increase in the proportion of railway accidents to passenger miles is probably chiefly due to a larger number of trifling bruises being reported now than formerly.

I believe it was a former President of the Board of Trade who said to an alarmed deputation, who waited upon him on the subject of railway travelling, that he thought he was safer in a railway carriage than anywhere else.

If he gave any such opinion he was not far wrong, as is sufficiently evident when it can be said that there is only one passenger injured in every four million miles travelled, or that, on an average, a person may travel 100,000 miles each year for forty years, and the chances be slightly in his favour of his not receiving the slightest injury.

A pressing subject of the present time is the economy of fuel. Members of the British Association have not neglected this momentous question.

At the meeting held at Newcastle-on-Tyne in 1863, Sir William Armstrong sounded an alarm as to the proximate exhaustion of our coal-fields.

Table on opposite page

Mr. Bramwell, when presiding over the Mechanical Section at Brighton, drew attention to the waste of fuel.

Dr. Siemens, in an able lecture he delivered by request of the Association to the operative classes at the meeting at Bradford, pointed out the waste of fuel in special branches of the iron trade, to which he has devoted so much attention.

He showed on that occasion that, in the ordinary re-heating furnace, the coal consumed did not produce the twentieth part of its theoretical effect, and in melting steel in pots in the ordinary way not more than one-seventieth part; in melting one ton of steel in pots about 2½ tons of coke being consumed. Dr. Siemens further stated that, in his regenerative gas furnace, one ton of steel was melted with 12 cwt. of small coal.

Mr. Lowthian Bell, who combines chemical knowledge with the practical experience of an ironmaster, in his Presidential address to the members of the Iron and Steel Institute in 1873, stated that, with the perfect mode of withdrawing and utilising the gases and the improvement in the furnaces adopted in the Cleveland district, the present make of pig-iron in Cleveland is produced with 3½ million tons of coal less than would have been needed fifteen years ago; this being equivalent to a saving of 45 per cent. of the quantity formerly used. He shows by figures with which he has favoured me, that the calorific power of the waste gases from the furnaces is sufficient for raising all the steam and heating all the air the furnaces require.

It has already been stated that by working steam more expansively, either in double or single engines, the consumption of fuel in improved modern engines compared with the older forms may be reduced to one-third.

All these reductions still fall far short of the theoretical effect of fuel which may be never reached. Mr. Lowthian Bell's figures go to show that in the interior of the blast furnace, as improved in Cleveland, there is not much more to be done in reducing the consumption of fuel; but much has already been done, and could the reductions now attainable, and all the information already acquired be universally applied, the saving in fuel would be enormous.

How many open blast furnaces still belch forth flame and gas and smoke as uselessly, and with nearly as much mischief to the surrounding neighbourhood, as the fires of Etna or Vesuvius? How many of the older and more extravagant forms of steam-engine still exist?

What is to be done with the intractable householder, with the domestic hearth, where, without going to German stoves, but by using Galton's grates and other improvements, everything necessary both for comfort and convenience could be as well attained with a much smaller consumption of coal?

If I have pointed out that we do not avail ourselves of more than a fractional part of the useful effects of fuel, it is not that I expect we shall all at once mend our ways in this respect. Many cases of waste arise from the existence of old and obsolete machines, of bad forms of furnaces, of wasteful grates, existing in most dwelling-houses; and these are not to be remedied at once, for not everyone can afford, however desirable it might be, to cast away the old and adopt the new.

In looking uneasily to the future supply and cost of fuel, it is, however, something to know what may be done even with the application of our present knowledge; and could we apply it universally to-day, all that is necessary for trade and comfort could probably be as well provided for by one-half the present consumption of fuel; and it behoves those who are beginning to build new mills, new furnaces, new steamboats, or new houses, to act as though the price of coal which obtained two years ago had been the normal and not the abnormal price.

There was in early years a battle of the gauges, and there is now a contest about guns; but your time will not permit me to say much on their manufacture.

Here again the progress made in a few years has been enormous; and in contributing to it, two men, Sir Wm. Armstrong and Sir Joseph Whitworth, both civil engineers, in this country at all events, deservedly stand foremost. The iron coil construction of Sir William Armstrong has already produced remarkable and satisfactory results; in discussing further possible improvements, the question is embarrassed by attempting to draw sharp lines between what is called steel and iron.

There is nothing that I can see to limit the size of guns, except the tenacity and endurance of the metal, whatever we may choose to call it, of which they are to be made.

Sir Joseph Whitworth, who has already done more than any other man in his department to secure good workmanship, and whose ideal of perfection is ever expanding, has long been seeking, and not without success, by enormous compression, to increase those qualities in what he calls homogeneous metal. Make the metal good enough, and call it iron if you will, and the size of a gun may be anything: the mere construction and handling of a gun of 100 tons, or of far greater weight, with suitable mechanical appliances, presents no difficulty.

Relying on the qualities of his compressed metal, Sir Joseph is now seeking by a singular experiment to limit the travel of the recoil, as far as practicable, to the elasticity of the metal. By

RAILWAY ACCIDENTS.—*Great Britain and Ireland.*

Year.	Proportion of train mileage for year to total length of single line of way, excluding sidings.	Number of accidents to passenger trains.	Average journey of passengers of all classes, exclusive of periodical ticket-holders.	Number of accidents to passengers from causes beyond their control.			Number of miles travelled by passengers of all classes, including periodical ticket-holders.	Proportion of passengers killed from causes beyond their control to passenger miles travelled.	Proportion of passengers injured or killed from causes beyond their control to passenger miles travelled.	Proportion of passengers killed from causes beyond their control to passenger journeys.	Proportion of passengers injured or killed from causes beyond their control to passenger journeys.
				Killed.	Injured.	Total.					
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
	(*a*)	No.	miles.	No.	No.	No.	(*b*) miles.	(*c*) miles.	(*d*) miles.	(*e*) No.	(*f*) No.
1846		51	18·80	5	146	151	894.573,000	1 in 178,915,000	1 in 5,924,000	1 in 9,514,000	1 in 315,000
1849		33	18·21	5	84	89	1,162,806,000	1 in 232,561,000	1 in 13,065,000	1 in 12,768 000	1 in 717,000
1852		60	16·19	10	372	382	1,473,255,000	1 in 147,326,000	1 in 3 857,000	1 in 8,910 000	1 in 241,000
1855	5,134	75	15·34	10	311	321	1,864,175,000	1 in 186,418,000	1 in 5 807,000	1 in 12,316 000	1 in 384,000
1858	5,418	48	14·54	25	419	444	2,084,353,000	1 in 83.374,000	1 in 4,694,000	1 in 5,809 000	1 in 3 7,000
1861	5,921	55	14·21	46	780	826	2,547,653,000	1 in 55,384,000	1 in 3,084,000	1 in 3,947,000	1 in 220,000
1864	6,395	75	12 47	14	697	711	2,966,592,000	1 in 211,899,000	1 in 4,172 000	1 in 17,141,000	1 in 335 000
1867	6,724	94	11·56	19	689	708	3,478,262,000	1 in 183,066,000	1 in 4,913,000	1 in 15 947,000	1 in 4 8,000
1870	7,253	123	10 74	65	1084	1149	3.801,734.000	1 in 58,488,000	1 in 3,309,000	1 in 5,465,000	1 in 3 9,000
1873	7,894		10 53	38	1504	1542	5.060,329 000	1 in 133,167,000	1 in 3,282,000	1 in 12,683,000	1 in 3 3,000
Average	1852–61	(inclusive)		[illegible]	425	445	2,018.485,000	1 in 100,924,000	1 in 4 536,000	1 in 6,850,000	1 in 08,000
Average	1864–73	(inclusive)		26	920	946	3,826.729,000	1 in 147,182,000	1 in 4,045 000	1 in 13,165,000	1 in 362,000

(*a*) The figures in this column are obtained by dividing the total train mileage by the aggregate length of single line of way, excluding sidings, and not by the actual length of the railway.

(*b*) The passenger mileage has been calculated, as it is not given in the Board of Trade returns, except partially between 1852 and 1859 (inclusive), and since 1859 no return under this head has been made.

(*c*) The figures in column No. IX. are obtained by dividing those in column VIII. by those in column V.

(*d*) The figures in column X. are obtained by dividing those in column VIII. by those in column VII.

(*e*) The figures in column XI. are obtained by dividing the total number of passengers carried in each year (including a calculated number of journeys made by season ticket holders) by the figures in column V.

(*f*) The figures in column XII. are obtained by dividing the total number of passengers carried in each year by the figures in column VII.

N.B.—The passenger mileage includes the miles estimated to have been travelled by season ticket holders. This estimate was obtained by calculating an average fare per mile for each class of passenger, and dividing the receipts from the season ticket holders by the average fare.

attaching the muzzle of the gun to an outer casing, through which the force of the recoil is carried back to the trunnions, he proposes to avail himself of this elasticity to the extent of one-and-a-half times the length of the gun; whether its elasticity alone in so short a space will suffice without aid is, perhaps, doubtful; but other aid may be applied, and the experiment, whether successful or not, will be interesting.

Docks and harbours I have no time to mention, for it is time this long and, I fear, tedious address, should close.

"Whence and whither," is an aphorism which leads us away from present and plainer objects to those which are more distant and obscure; whether we look backwards or forwards, our vision is speedily arrested by an impenetrable veil.

On the subjects I have chosen you will probably think I have travelled backwards far enough. I have dealt to some extent with the present.

The retrospect, however, may be useful to show what great works were done in former ages.

Some things have been better done than in those earlier times, but not all.

In what we choose to call the ideal we do not surpass the ancients. Poets and painters and sculptors were as great in former times as now; so, probably, were the mathematicians.

In what depends on the accumulation of experience, we ought to excel our forerunners. Engineering depends largely on experience; nevertheless, in future times, whenever difficulties shall arise or works have to be accomplished for which there is no precedent, he who has to perform the duty may step forth from any of the walks of life, as engineers have not unfrequently hitherto done.

The marvellous progress of the last two generations should make everyone cautious of predicting the future. Of engineering works, however, it may be said that their practicability or impracticability is often determined by other elements than the inherent difficulty in the works themselves. Greater works than any yet achieved remain to be accomplished—not perhaps yet awhile. Society may not yet require them; the world could not at present afford to pay for them.

The progress of engineering works, if we consider it, and the expenditure upon them, has already in our time been prodigious. One hundred and sixty thousand miles of railway alone, put into figures at 20,000*l.* a mile, amounts to 3,200 million pounds sterling; add 400,000 miles of telegraph at 100*l.* a mile, and 100 millions more for sea canals, docks, harbours, water and sanitary works constructed in the same period, and we get the enormous sum of 3,340 millions sterling expended in one generation and a half on what may undoubtedly be called useful works.

The wealth of nations may be impaired by expenditure on luxuries and war; it cannot be diminished by expenditure on works like these.

As to the future, we know we cannot create a force; we can, and no doubt shall, greatly improve the application of those with which we are acquainted. What are called inventions can do no more than this, yet how much every day is being done by new machines and instruments.

The telescope extended our vision to distant worlds. The spectroscope has far outstripped that instrument, by extending our powers of analysis to regions as remote.

Postal deliveries were and are great and able organisations, but what are they to the telegraph?

Need we try to extend our vision into futurity farther? Our present knowledge, compared to what is unknown even in physics, is infinitesimal. We may never discover a new force—yet, who can tell?

SECTION A.

MATHEMATICAL AND PHYSICAL.

OPENING ADDRESS BY THE PRESIDENT, PROF. BALFOUR STEWART.

Since the last meeting of the British Association, science has had to mourn the loss of one of its pioneers, in the death of the veteran astronomer, Schwabe, of Dessau, at a good old age, not before he had faithfully and honourably finished his work. In truth this work was of such a nature that the worker could not be expected long to survive its completion.

It is now nearly fifty years since he first began to produce daily sketches of the spots that appeared upon the sun's surface. Every day on which the sun was visible (and such days are more frequent in Germany than in this country), with hardly any intermission for forty years, this laborious and venerable observer made his sketch of the solar disc. At length this unexampled perseverance met with its reward in the discovery of the periodicity of sun-spots, a phenomenon which very speedily attracted the attention of the scientific world.

It is not easy to over-rate the importance of the step gained when a periodicity was found to rule these solar outbreaks. *A priori* we should not have expected such a phenomenon. If the old astronomers were perplexed by the discovery of sun-spots, their successors must have been equally perplexed when they ascertained their periodicity. For while all are ready to acknowledge periodicity as one of the natural conditions of terrestrial phenomena, yet everyone is inclined to ask what there can be to cause it in the behaviour of the sun himself. Manifestly it can only have two possible causes. It must either be the outcome of some strangely hidden periodical cause residing in the sun himself, or must be produced by external bodies, such as planets, acting somehow in their varied positions on the atmosphere of the sun. But whether the cause be an internal or external one—in either case we are completely ignorant of its nature.

We can easily enough imagine a cause operating from the sun himself and his relations with a surrounding medium to produce great disturbances on his surface, but we cannot easily imagine why disturbances so caused should have a periodicity. On the other hand we can easily enough attach periodicity to any effect caused by the planets, but we cannot well see why bodies comparatively so insignificant should contribute to such very violent outbreaks as we now know sun-spots to be.

If we look within we are at a loss to account for the periodicity of solar disturbances, and if we look without we are equally at a loss to account for their magnitude. But since that within the sun is hidden from our view, it cannot surely be considered blameworthy if astronomers have directed their attention to that without and have endeavoured to connect the behaviour of sun-spots with the positions of the various planets. Stimulated no doubt by the success which had attended the labours of Schwabe, an English astronomer was the next to enter the field of solar research.

The aim of Mr. Carrington was, however, rather to obtain very accurate records of the positions, the sizes, and the shapes of the various sun-spots than to make a very extensive and long-continued series of observations. He was aware that a series at once very accurate and very extended is beyond the power of a private individual, and can only be undertaken by an established institution. Nevertheless, each sun-spot that made its appearance during the seven years extending from the beginning of 1854 to the end of 1860 was sketched by Mr. Carrington with the greatest possible accuracy, and had also its heliographic position, that is to say its solar latitude and longitude, accurately determined.

One of the most prominent results of Mr. Carrington's labours was the discovery of the fact that sun-spots appear to have a proper motion of their own—those nearer the solar equator moving faster than those more remote. Another was the discovery of changes apparently periodical affecting the disposition of spots in solar latitude. It was already known that sun-spots confined themselves to the sun's equatorial regions, but Mr. Carrington showed that the region affected was liable to periodical elongations and contractions, although his observations were not sufficiently extended to determine the exact length of this period.

Before Mr. Carrington had completed his seven' years labours, celestial photography had been introduced by Mr. Warren De la Rue. Commencing with his private observatory, he next persuaded the Kew Committee of the British Association to allow the systematic photography of the sun to be carried on at their observatory under his superintendence, and in the year 1862 the first of a ten years' series of solar photographs was begun. Before this date however Mr. De la Rue had ascertained, by means of his photoheliograph, on the occasion of the total eclipse of 1860, that the red prominences surrounding the eclipsed sun, belong, without doubt, to our luminary himself.

The Kew observations are not yet finally reduced, but already several important conclusions have been obtained from them by Mr. De la Rue and the other Kew observers. In the first place the Kew photographs confirm the theory of Wilson that sun-spots are phenomena, the dark portions of which exist at a level considerably beneath the general surface of the sun; in other words, they are hollows, or pits, the interior of which is of course filled up with the solar atmosphere. The Kew observers were likewise led to associate the low temperature of the bottom of sun-spots with the downward carriage of colder matter from the atmosphere of the sun, while the upward rush of heated matter was supposed to account for the faculæ or bright patches which almost invariably accompany spots. In the next place the Kew observers, making use not only of the Kew series but of those of Schwabe and Carrington, which were generously placed at their disposal, have discovered traces of the influence of the nearer planets upon the behaviour of sun-spots. This influence appears to be of such a nature that spots attain their maximum size when carried by rotation into positions as far as possible remote from the influencing planet—that is to say into positions where the body of the sun is between them and the planet. There is also evidence of an excess of solar action when two influential planets come near together. But although considerable light has thus been thrown on the periodicity of sun-spots, it ought to be borne in mind that the cause of the remarkable period of eleven years and a quarter, originally discovered by Schwabe, has not yet been properly explained. The Kew observers have likewise discovered traces of a peculiar oscillation of spots between the two hemispheres of the sun, and finally their researches will place at the command of the observers the data for ascertaining whether centres of greater and lesser solar activity are connected with certain heliocentric positions.

While the sun's surface was thus being examined both telescopically and photographically, the spectroscope came to be employed as an instrument of research. It had already been surmised by Prof. Stokes, that the vapour of sodium at a comparatively low temperature forms one of the constituents of the solar atmosphere, inasmuch as the dark line D in the spectrum of the sun coincides in position with the bright line given out by incandescent sodium vapour.

This method of research was greatly extended by Kirchhoff, who soon found that many of the dark lines in the solar spectrum were coincident with the bright lines of sundry incandescent metallic vapours, and a good beginning was thus made towards ascertaining the chemical constitution of the sun.

The new method soon brought forth further fruit when applied in the hands of Huggins, Miller, Secchi, and others, to the more distant heavenly bodies. It was speedily found that the fixed stars had constitutions very similar to that of the sun. But a peculiar and unexpected success was attained when some of the nebulæ were examined spectroscopically. To-day it seems (so rapidly has knowledge progressed) very much like recalling an old superstition to remind you that until the advent of the spectroscope the irresolvable nebulæ were considered to be gigantic and remote clusters of stars, the individual members of which were too distant to be separated from each other even with a telescope like that of Lord Rosse. But Mr. Huggins, by means of the spectroscope, soon found that this was not the case, and that most of the nebulæ which had defied the telescope gave indications of incandescent hydrogen gas. It was also found by this observer that the proper motions of some of the fixed stars in a direction to or from the earth might be detected by means of the displacement of their spectral lines, a method of research which was first enunciated by Fizeau. Hitherto in such applications of the spectroscope, the body to be examined was viewed as a whole. It had not yet been attempted to localise the use of this instrument so as to examine particular districts of the sun, as for instance a sun-spot, or the red flames already proved by De la Rue to belong to our luminary. This application was first made by Mr. Lockyer, who in the year 1865 examined a sun-spot spectroscopically and remarked the greater thickness of the lines in the spectrum of the darker portion of the spot.

Dr. Frankland had previously found that thick spectral lines correspond to great pressure, and hence the inference from the greater thickness of lines in the umbra of a spot is that this umbra or dark portion is subject to a greater pressure; that is to say, it exists below a greater depth of the solar atmosphere than the general surface of the sun. Thus the results derived from the Kew photoheliograph and those derived from the spectroscope were found to confirm each other. Mr. Lockyer next caused a powerful instrument to be constructed for the purpose of viewing spectroscopically the red flames round the sun's border, in the hope that if they consisted of ignited gas the spectroscope would disperse, and thus dilute and destroy the glare which prevents them from being seen on ordinary occasions.

Before this instrument was quite ready these flames had been analysed spectroscopically by Capt. Herschel, M. Janssen, and others, on the occasion of a total eclipse occurring in India, and they were found to consist of incandescent gas, most probably hydrogen. But the latter of these observers (M. Janssen) made the important observation that the bright lines in the spectrum of these flames remained visible even after the sun had reappeared, from which he argued that a solar eclipse is not necessary for the examination of this region.

Before information of the discovery made by Janssen had reached this country, the instrument of Mr. Lockyer had been completed, and he also found that by its means he was able to analyse at leisure the composition of the red flames without the necessity of a total eclipse. An atmosphere of incandescent hydrogen was found to surround our luminary into which, during the greater solar storms, sundry metallic vapours were injected, sodium, magnesium, and iron forming the three that most frequently made their appearance.

Here we come to an interesting chemical question.

It had been remarked by Maxwell and by Pierce as the result of the molecular theory of gases that the final distribution of any number of kinds of gas in a vertical direction under gravity is such that the density of each gas at a given height is the same as if all the other gases had been removed, leaving it alone. In our own atmosphere the continual disturbances prevent this arrangement from taking place, but in the sun's enormously extended atmosphere (if indeed our luminary be not nearly all gaseous) it appears to hold, inasmuch as the upper portion of this atmosphere, dealing with known elements, apparently consists entirely of hydrogen. Various other vapours are, however, as we have seen, injected from below the photosphere into the solar atmosphere on the occasion of great disturbances, and Mr. Lockyer has asked the question, whether we have not here a true indication of the relative densities of these various vapours derived from the relative heights to which they are injected on such occasions.

This question has been asked, but it has not yet received a definite solution, for chemists tell us that the vapour densities of some of the gases injected into the sun's atmosphere on the occasion of disturbances are, as far as they know from terrestrial observations, different from those which would be indicated by taking the relative heights attained in the atmosphere of the sun. Mr. Lockyer has attempted to bring this question a step nearer to its solution by showing that the vapours at the temperatures at which their vapour densities have been experimentally determined are not of similar molecular constitution, whereas in the sun we get an indication, from the fact that all the elements give us line spectra, that they are in similar molecular states.

Without, however, attempting to settle this question, I may remark that we have here an interesting example of how two branches of science—physics and chemistry—meet together in solar research.

It had already been observed by Kirchhoff that sometimes one or more of the spectral lines of an elementary vapour appeared to be reversed in the solar spectrum, while the other lines did not experience reversal. Mr. Lockyer succeeded in obtaining an explanation of this phenomenon. This explanation was found by means of the method of localisation already mentioned.

Hitherto, when taking the spectrum of the electric spark between the two metallic poles of a coil, the arrangements were such as to give an average spectrum of the metal of these poles; but it was found that when the method of localisation was employed, different portions of the spark gave a different number of lines, the regions near the terminals being rich in lines, while the midway regions give comparatively few.

If we imagine that in the midway regions the metallic vapour given off by the spark is in a rarer state than that near the poles, we are thus led to regard the short lines which cling to the poles as those which require a greater density or nearness of the vapour particles before they make their appearance; while on the other hand, those which extend all the way between the two poles come to be regarded as those which will continue to make their appearance in vapour of great tenuity.

Now it was remarked that these long lines were the very lines which were reversed in the atmosphere of the sun. Hence when we observe a single coincidence between a dark solar line and the bright line of any metal, we are further led to inquire whether this bright line is one of the long lines which will continue to exist all the way between two terminals of that metal when the spark passes.

If this be the case, then we may argue with much probability that the metal in question really occurs in the solar atmosphere; but if, on the other hand, the coincidence is merely between a solar dark line and a short bright one, then we are led to imagine that it is not a true coincidence, but something which will probably disappear on further examination. This method has already afforded us a means of determining the relative amount of the various metallic vapours in the sun's atmosphere. Thus, in some instances all lines are reversed, whereas in others the reversal extends only to a few of the longer lines.

Several new metals have thus been added to the list of those previously detected in the solar atmosphere, and it is now certain that the vapours of hydrogen, potassium, sodium, rubidium, barium, strontium, calcium, magnesium, aluminium, iron, manganese, chromium, cobalt, nickel, titanium, lead, copper, cadmium, zinc, uranium, cerium, vanadium, and palladium occur in our luminary.

I have spoken hitherto only of telescopic spectroscopy; but photography has been found capable of performing the same good service towards the compound instrument consisting of the telescope and its attached spectroscope, which it had previously been known to perform towards the telescope alone. It is of no less importance to secure a permanent record of spectral peculiarities than it is to secure a permanent record of telescopic appearances. This application of photography to spectrum observations was first commenced on a sufficient scale by Mr. Rutherford, of New York, and already promises to be one of the most valuable aids in solar inquiry.

In connection with the spectroscope I ought here to mention the names of Respighi, and Secchi, who have done much in the examination of the solar surface from day to day. It is of great importance to the advancement of our knowledge, that two such competent observers are stationed in a country where the climate is so favourable to continued observation.

The examination of the sun's surface by the spectroscope suggests many interesting questions connected with other branches of science. One of these has already been alluded to. I may mention two others put by Mr. Lockyer, premising, however, that at present we are hardly in a position to reply to them. It has been asked whether the very high temperatures of the sun and of some of the stars may not be sufficient to produce the disassociation of those molecular structures which cannot be disassociated by any terrestrial means; in other words, the question has been raised, whether our so-called elements are really elementary bodies.

A third question is of geological interest. It has been asked whether a study of the solar atmosphere may not throw some light upon the peculiar constitution of the upper strata of the earth's surface, which are known to be of less density than the average interior of our planet.

If we have learned to be independent of total eclipses as far as the lower portions of the solar atmosphere are concerned, it must be confessed that as yet the upper portions—the outworks of the sun—can only be successfully approached on these rare and precious occasions. Thanks to the various Government expeditions despatched by Great Britain, by the United States, and by several Continental nations—thanks, also, to the exertions of Lord Lindsay and other astronomers—we are in the possession of definite information regarding the solar corona.

In the first place, we are now absolutely certain that a large part of this appendage unmistakably belongs to our luminary, and in the next place, we know that it consists, in part at least, of an ignited gas giving a peculiar spectrum, which we have not yet been able to identify with that of any known element. The temptation is great to associate this spectrum with the presence of something lighter than hydrogen, of the nature of which we are yet totally ignorant.

A peculiar physical structure of the corona has likewise been suspected. On the whole, we may say that this is the least known, while it is perhaps the most interesting, region of solar research; most assuredly it is well worthy of further investigation.

If we now turn our attention to matters nearer home, we find that there is a difficulty in grasping the facts of terrestrial meteorology no less formidable than that which assails us when we investigate solar outbreaks. The latter perplex us because the sun is so far away and because also his conditions are so different from those with which we are here familiar; while on the other hand, the former perplex us because we are so intimately mixed up with them in our daily lives and actions; because, in fact, the scale is so large and we are so near. The result has been that until quite recently our meteorological operations have been conducted by a band of isolated volunteers individually capable and skilful, but from their very isolation incapable of combining together with advantage to prosecute a scientific campaign. Of late, however, we have begun to perceive that if we are to make any advance in this very interesting and practical subject, a different method must be pursued, and we have already reaped the first fruits of a more enlightened policy; already we have gained some knowledge of the constitution and habits of our atmosphere.

The researches of Wells and Tyndall have thrown much light on the cause of dew. Humboldt, Dové, Buys Ballot, Jelinek, Quetelet, Hansteen, Kupffer, Forbes, Welsh, Glaisher, and others have done much to give us an accurate knowledge of the distribution of terrestrial temperature. Great attention has likewise been given to the rainfall of Great Britain and Ireland, chiefly through the exertions of one individual, Mr. G. J. Symons.

To Dové we are indebted for the law of rotation of the wind, to Redfield for the spiral theory of cyclones, to Francis Galton for the theory of anti-cyclones, to Buchan for an investigation into the disposition of atmospheric pressure which precedes peculiar types of weather, to Stevenson for the conception of barometric gradients, to Scott and Meldrum for an acquaintance with the disposition of winds which frequently precedes violent outbreaks; and to come to the practical application of laws, we are much indebted to the late Admiral Fitzroy and the system which he greatly helped to establish for our telegraphic warnings of coming storms.

Again, the meteorology of the ocean has not been forgotten. The well-known name of Maury will occur to every one as that of a pioneer in this branch of inquiry. Fitzroy, Leverrier, Meldrum, Toynbee, and others have likewise done much; and it is understood that the meteorological offices of this and other maritime countries are now busily engaged upon this important and practical subject. Finally, the movements of the ocean and the temperatures of the oceanic depths have recently been examined with very great success in vessels despatched by her Majesty's Government; and Dr. Carpenter has by this means been able to throw great light upon the convection currents exhibited by that vast body of water which girdles our globe.

It would be out of place to enter here more minutely into this large subject, and already it may be asked what connection has all this with that part of the address that went before it.

There are, however, strong grounds for supposing that the meteorology of the sun and that of the earth are intimately connected together. Mr. Broun has shown the existence of a meteorological period connected apparently with the sun's rotation; five successive years' observations of the barometer at Singapore all giving the period 25·74 days. Mr. Baxendell, of Manchester, was, I believe, the first to show that the convection currents of the earth appear to be connected somehow with the state of the sun's surface as regards spots; and still more recently, Mr. Meldrum, of the Mauritius Observatory, has shown by a laborious compilation of ships' logs and by utilising the meteorological records of the island, that the cyclones in the Indian Ocean are most frequent in years when there are most sunspots. He likewise affords us grounds for supposing that the rainfall, at least in the tropics, is greatest in years of maximum solar disturbance.

M. Poey has found a similar connection in the case of the West Indian hurricanes; and finally, Piazzi Smyth, Stone, Köppen, and still more recently, Blanford, have been able to bring to light a cycle of terrestrial temperature having apparent reference to the condition of the sun.

Thus, we have strong matter-of-fact grounds for presuming a connection between the meteorology of our luminary and that of our planet, even although we are in complete ignorance as to the exact nature of this bond.

If we now turn to terrestrial magnetism the same connection becomes apparent.

Sir Edward Sabine was the first to show that the disturbances of the magnetism of the earth are most violent during years of maximum sunspots. Mr. Broun has shown that there is likewise a reference in magnetic phenomena to the period of the sun's rotation about his axis, an observation recently confirmed by Hornstein; and still more recently, Mr. Broun has shown that the moon has an action upon the earth's magnetism which is not altogether of a tidal nature, but depends, in part, at least, upon the relative position of the sun and moon.

I must trust to your forbearance if I now venture to bring forward considerations of a somewhat speculative nature.

We are all familiar with the generalisation of Hadley, that is to say we know there are under-currents sweeping along the surface of the earth from the poles to the equator, and upper-currents sweeping back from the equator to the poles. We are likewise aware that these currents are caused by the unequal temperature of the earth; they are in truth convection-currents, and their course is determined by the positions of the hottest and coldest parts of the earth's surface. We may expect them, therefore, to have a reference not so much to the geographical equator and poles as to the hottest and coldest regions. In fact, we know that the equatorial regions into which the trade winds rush and from which the anti-trades take their origin, have a certain annual oscillation depending upon the position of the sun, or in other words upon the season of the year. We may likewise imagine that the region into which the upper-currents pour themselves is not the geographical pole, but the pole of greatest cold.

In the next place we may imagine that these currents, as far as regards a particular place, have a daily oscillation. This has, I believe, been proved as regards the lower currents or trade-winds which are more powerful during the day than during the night, and we may therefore expect it to hold good with regard to the upper-currents or anti-trades; in fact, we cannot go wrong in supposing that they also, as regards any particular place, exhibit a daily variation in the intensity with which they blow.

Again, we are aware that the earth is a magnet. Let us not now concern ourselves about the origin of its magnetism, but rather let us take it as it is. We must next bear in mind that rarefied air is a good conductor of electricity; indeed, according to recent experiments, an extremely good conductor. The return trades that pass above from the hotter equatorial regions to the poles of cold, consisting of moist rarefied air, are therefore to be regarded in the light of good conductors crossing lines of magnetic force; we may therefore expect them to be the vehicle of electric currents. Such electric currents will of course react on the magnetism of the earth. Now, since the velocity of these upper currents has a daily variation, their influence as exhibited at any place upon the magnetism of the earth may be expected to have a daily variation also.

The question thus arises, Have we possibly here a cause which may account for the well-known daily magnetic variation? Are the peculiarities of this variation such as to correspond to those which might be expected to belong to such electric currents? I think it may be said that as far as we can judge there is a likeness of this kind between the peculiarities of these two things, but a more prolonged scrutiny will of course be essential before we can be absolutely certain that such currents are fitted to produce the daily variation of the earth's magnetism.

Besides the daily and yearly periodic changes in these upper convection currents we should also expect occasional and abrupt changes forming the counterparts of those disturbances in the lower strata with which we are familiar. And these may be expected in like manner to produce non-periodic occasional disturbances of the magnetism of the earth. Now it is well known that such disturbances do occur, and further that they are most frequent in those years when cyclones are most frequent, that is to say in years of maximum sunspots. In one word, it appears to be a tenable hypothesis to attribute at least the most prominent magnetic changes to atmospheric motions taking place in the upper regions of the atmosphere where each moving stratum of air becomes a conductor moving across lines of magnetic force; and it was Sir Wm. Thomson, I believe, who first suggested that the motion of conductors across the lines of the earth's magnetic force must be taken into account in any attempted explanation of terrestrial magnetism.

It thus seems possible that the excessive magnetic disturbances which take place in years of maximum sunspots may not be directly caused by any solar action, but may rather be due to the excessive meteorological disturbances which are likewise characteristic of such years. On the other hand, that magnetic and meteorological influence which Mr. Broun has found to be connected with the sun's rotation points to some unknown direct effect produced by our luminary, even if we imagine that the magnetic part of it is caused by the meteorological. Mr. Broun is of opinion that this effect of the sun does not depend upon the amount of spots on his surface.

In the next place, that influence of the sun in virtue of which we have most cyclones and greater meteorological disturbance in the years of maximum spots cannot, I think (as far as we know at present), be attributed to a change in the heating power of the sun. We have no doubt traces of a temperature effect which appears to depend upon the sun-period, but its amount is very small, whereas the variation in cyclonic disturbance is very great. We are thus tempted to associate this cyclone producing influence of the sun with something different from his light and heat. As far, therefore, as we can judge, our luminary would appear to produce three distinct effects upon our globe. In the first place, a magnetic and meteorological effect, depending somehow upon his rotation: secondly, a cyclonic effect depending somehow upon the disturbed state of his surface; and lastly, the well-known light and heat effect with which we all are familiar.

If we now turn to the sun we find that there are three distinct forms of motion which animate his surface particles. In the first place, each particle is carried round by the rotation of our luminary. Secondly, each particle is influenced by the gigantic meteorological disturbances of the surface, in virtue of which it may acquire a velocity ranging as high as 130 or 140 miles a second; and lastly, each particle, on account of its high temperature, is vibrating with extreme rapidity, and the energy of these vibrations communicated to us by means of the ethereal medium produces the well-known light and heat effect of the sun.

Now, is it philosophical to suppose that it is only the last of these three motions that influences our earth, while the other two produce absolutely no effect? On the contrary, we are, I think, compelled by considerations connected with the theory of energy, to attribute an influence, whether great or small, to the first two as well as to the last.

We are thus led to suppose that the sun must influence the earth in three ways, one depending on his rotation, another on his meteorological disturbance, and a third by means of the vibrations of his surface particles.

But we have already seen that, as a matter of fact, the sun does appear to influence the earth in three distinct ways—one magnetically and meteorologically, depending apparently on his period of rotation; a second cyclonically, depending apparently on the meteorological conditions of his surface; and a third, by means of his light and heat.

Is this merely a coincidence, or has it a meaning of its own? We cannot tell; but I may venture to think that in the pursuit of this problem we ought to be prepared at least to admit the possibility of a three-fold influence of the sun.

Even from this very meagre sketch of one of the most interesting and important of physical problems, it cannot fail to appear that while a good deal has already been done, its progress in the future will very greatly depend on the completeness of the method and continuity of the observations by which it is pursued. We have here a field which is of importance not merely to one, or even to two, but almost to every conceivable branch of research.

Why should we not erect in it a sort of science exchange into which the physicist, the chemist, and the geologist may each carry the fruits of his research, receiving back in return some suggestion, some principle, or some other scientific commodity that will aid him in his own field. But to establish such a mart must be a national undertaking, and already several nations have acknowledged their obligations in this respect.

Already the German Government have established a Sonnenwarte, the mere building and equipment of which is to cost a large sum. With an appreciation of what the spectroscope has done for this inquiry, the first directorship was offered to Kirchhoff, and on his declining it, Herr Vogel has been placed in charge. In France also a physical observatory is to be erected at Fontenay, on an equal, if not greater scale, of which Janssen has already accepted the directorship; while in Italy there are at least three observatories exclusively devoted to this branch of research. Nor must we forget that in this country the new observatory at Oxford has been so arranged that it can be employed in such inquiries. But what has England as a nation done?

Some years since, at the Norwich meeting of this Association, a movement was set on foot by Col. Strange which resulted in the appointment of a Royal Commission on the advancement of science, with the Duke of Devonshire as chairman. This Commission have quite recently reported on the steps that ought in their opinion to be taken for the advancement of scientific research.

One of their recommendations is expressed in the following words:—

"Important classes of phenomena relating to physical meteorology and to terrestrial and astronomical physics require observations of such a character that they cannot be advantageously carried on otherwise than under the direction of Government. Institutions for the study of such phenomena should be maintained by the Government; and in particular an observatory should be founded specially devoted to astronomical physics."

If the men of science of this country who procured the appointment of this commission, and who subsequently gave evidence before it, will now come forward to support its recommendations, it can hardly be doubted that these will be speedily carried into effect.

But other things besides observations are necessary, if we are to pursue with advantage this great physical problem.

One of these is the removal of the intolerable burden that has hitherto been laid upon private meteorologists and magneticians. Expected to furnish their tale of bricks, they have been left to find their own straw. Nothing more wretched can be imagined than the position of an amateur—that is to say, a man who pursues science for the love of it and is unconnected with any establishment—who has set himself to promote observational inquiries, whether in meteorology or magnetism.

He has first to obtain with great expenditure of time or money, or both, copies of the individual observations taken at some recognised institution. He has next to reduce these in the way that suits his inquiry; an operation again consuming time and demanding means. Let us suppose all this to be successfully accomplished, and a valuable result obtained. It is doubtless embodied in the Transactions of some society, but it excites little enthusiasm, for it consists of something which cannot be repeated by every one for himself like a new and interesting experiment. Yet the position of such men has recently been improved. Several observatories and other institutions now publish their individual observations; this is done by our Meteorological Office, while Dr. Bergsma, Dr. Neumayer, and Mr. Broun are recent examples of magneticians who have adopted this plan. The publication of the work of the latter is due to the enlightened patronage of the Rajah of Travancore, who has thus placed himself in front of the princes of India and given them an example which it is to be hoped they will follow. But this is only one step in the right direction; another must consist in subsidising private meteorologists and magneticians in order to enable them to obtain the aid of computers in reducing the observations with which they have been furnished. The man of science would thus be able to devote his knowledge, derived from long study, to the methods by which results and the laws regulating them are to be obtained; he could be the architect and builder of a scientific structure without being forced to waste his energies on the work of a hodman.

Another hindrance consists in our deficient knowledge as to what observations of value in magnetism and meteorology have already been made. We ought to have an exhaustive catalogue of all that has been done in this respect in our globe, and of the conditions under which the various observations will be accessible to outside inquirers. A catalogue of this kind has been framed by a committee of this Association, but it is confined to the dominions of England, and requires to be supplemented by a list of that which has been done abroad.

A third drawback is the insufficient nature of the present facilities for the invention and improvement of instruments, and for their verification.

We have, no doubt, advanced greatly in the construction of instruments, especially in those which are self-recording. The names of Brooke, Robinson, Welsh, Osler, and Beckley will occur to us all as improvers of our instruments of observation. Sir W. Thomson has likewise adapted his electrometer to the wants of meteorology. Dr. Roscoe has given us a self-recording actinometer, but a good instrument for observing the sun's heat is still a desideratum. It ought likewise to be borne in mind that the standard mercurial thermometer is by no means a perfect instrument.

In conclusion, it cannot be doubted that a great generalisation is looming in the distance—a mighty law we cannot yet tell what, that will reach us, we cannot yet say when. It will involve facts hitherto inexplicable, facts that are scarcely received as such because they appear opposed to our present knowledge of their causes. It is not possible perhaps to hasten the arrival of this generalisation beyond a certain point; but we ought not to forget that we *can* hasten it, and that it is our duty to do so. It depends much on ourselves, our resolution, our earnestness; on the scientific policy we adopt, as well as on the power we may have to devote ourselves to special investigations, whether such an advent shall be realised in our day and generation, or whether it shall be indefinitely postponed. If governments would understand the ultimate *material* advantages of every step forward in science, however inapplicable each may appear for the moment to the wants or pleasures of ordinary life, they would find reasons patent to the meanest capacities for bringing the wealth of mind, now lost on the drudgery of common labours, to bear on the search for those wondrous laws which govern every movement not only of the mighty masses of our system, but of every atom distributed throughout space.

SECTION C.

OPENING ADDRESS OF DR. THOMAS WRIGHT, F.R.S.E., F.G.S., PRESIDENT.

On the Geological and Palæontological Character of the Country around Bristol.

In taking this Chair to-day, I desire first to express my deep sense of gratitude to the Council of the British Association for the honour conferred on me, and secondly, to say how much I feel the responsibility of the position in which I am placed when I recollect the long list of distinguished *savans* who in former years have presided over this Section. The fact that Buckland, Conybeare, De la Beche, Forbes, Geikie, Hopkins, Jukes, Lyell, Murchison, Phillips, Ramsay, and other men illustrious in the annals of British Geology have filled this chair, may well make me doubt how far my own feeble powers are equal to an efficient discharge of its duties; however, I shall bring a willing mind and an honest determination to do my best on this occasion.

We have met again in one of the most interesting centres in England to all students of practical geology; for within a short distance of this spot we can examine some of the most instructive sections of Palæozoic and Mesozoic rocks, and study a magnificent collection of local fossils obtained from them. So I purpose occupying the short space of time allowed for this introductory address in attempting to give you a general outline of the geological character of the country around Bristol, with a *résumé* of some of its more remarkable Palæontological features, by way of inducing you to visit and study the admirable collection of local organic remains so well displayed in the Museum of the Bristol Philosophical Institution.

Geology is the history of the Earth; for it attempts to construct a table of phenomena, physical and chemical, organic and inorganic, which have succeeded each other from the past to the present, and on the terrestrial surface traces of its origin and progress are preserved.

That phase which we see to-day is only the most recent of its eventful history, and although the last, is not the final one, as the physical forces that are ever in action among its different parts are slowly and steadily producing new combinations, which in time will effect mutations in its structure, change its physiography, and remodel the whole.

There is probably no other place in England where, within so limited an area, typical examples of so many different formations occur as around this city; for within a short distance by road or rail we may investigate the Silurian, Devonian, Carboniferous, Triassic, Liassic, Oolitic, and Cretaceous formations, all of which will yield many interesting species for the cabinet of the palæontologist, and a valuable series of rocks and minerals for the student of Physical Geology.

These different formations in relation to the entire series of stratified rocks will be better understood by a reference to the Table on the following page, in which the periods, divisions, formations, and typical localities are given.

The localities in the Table may be grouped into six districts:—

1. Tortworth district.
2. Mendip Hills.
3. Radstock district.
4. Bristol district.
5. Dundry district.
6. Bridgewater district.

1. TORTWORTH DISTRICT.

Silurian.—Tortworth has long been classical ground to the geologist, and was first brought into notice by Dr. Cooke, formerly (1799–1835) rector of the parish. This gentleman made an extensive collection of fossils from all the rocks in the district, which after his death passed through my hands, and I can therefore speak to the fact. A description of the Geology of Tortworth was made by Mr. Weaver,[1] and by Buckland and Conybeare.[2] These memoirs were written at a time when the correlations of the then so-called Transition rocks were not understood; therefore they help us little toward a correct understanding of their age and character; it was not until Murchison had succeeded in making out the true relation and character of the upper fossiliferous beds beneath the Old Red Sandstone, and had arranged his groups by their organic remains in consecutive order under the name of the Silurian System, that the true age and relation of the Transition strata of Tortworth were understood. It then appeared that the Silurian rocks of Tortworth are the southern extension of the same formations which, extending through Micklewood Chase and the Vale of Berkeley, appear as a dome of Upper Silurian, rising near Tites Point on the left bank of the Severn near Purton Passage. The same rocks are found wrapping round the base of May Hill and Huntley Hill in the Forest of Dean, in the Valley of Woolhope, Herefordshire, on the western slopes of the Malvern Hills, and extending through Eastnor and Ledbury to Wenlock Edge, Salop. Whatever, therefore, is true relating to the Palæontological character of the Upper Silurians in these other localities, is equally correct of the same formations that lie in the miniature basin of Tortworth. The *Caradoc Sandstone*, or, as it is now called, the *Upper Llandovery Sandstone*, is the oldest rock at Tortworth, and forms the dominant stratum of the district. It covers an extensive area; and some small sections are seen at the south side of Micklewood Chase, and on both banks of the Avon near Damory Mill. Lithologically and palæontologically it is indistinguishable from hand specimens of the same formation at May Hill. It abounds in fossils: *Pentamerus*, *Strophomena*, *Orthis*, *Atrypa*, *Spirifera*, and *Leptæna*, with broken Trilobites belonging to the genera *Trinucleus*, *Calymene*, *Illænus*, and *Phacops*, are found, together with the stems of Crinoids and Tentaculites.

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[1] Trans. Geol. Soc. vol. i. p. 317 (2nd series).

[2] Ibid. p. 210.

The *Wenlock Limestone* is exposed at Falfield Mill and Whitfield, and other places; from its various beds the characteristic Upper Silurian Corals are collected, as *Favosites*, *Syringopora*, *Halysites*, *Porites*, *Caryophyllia*, and *Acervularia*. Crinoidal stems are very abundant. Many Brachiopoda, as *Leptæna*, *Atrypa*, *Orthis orbicularis*, and Gasteropoda, as *Euomphalus discors* and *Euomphalus funatus*, are collected, with fragments of *Calymene Blumenbachii* and *Phacops caudatus*. The *Ludlow Rock* is best exposed at low-water mark on the west bank of the Severn at Purton Passage, where it rises in a dome-shaped mass, and dips away beneath the beds of Old Red Sandstone of the Devonian series on the opposite shore; the upper portion of this formation consists of greenish-grey micaceous beds, with *Leptæna lata*, *Orthis unguis*, and *Terebratula Wilsoni*, which probably represent the Aymestry limestone.

TABLE I.—Geological Formations in the Bristol Districts.

Periods.	Divisions.	Formations.	Typical Localities.
POST TERTIARY	Recent	Alluvium	Bristol, Shirehampton.
		Peat	Cheddar, Glastonbury.
	Post Pliocene	Gravel	Cheddar railway, Keynsham, Saltford.
TERTIARY	- - -	- - - -	Absent.
CRETACEOUS	- - -	Greensand	Postlebury.
JURASSIC	Upper Oolite	Coral Rag	Absent.
	Middle Oolite	Oxford Clay	Cloford.
	Lower Oolite	Cornbrash	Cloford, Marston Bigot.
		Forest Marble	Chickwell, Faulkland.
		Bradford Clay	Bradford.
		Bath Oolite	Coombedown Lansdown P.
		Fuller's Earth	North Stoke, Lansdown, Box.
		Inferior Oolite	Dundry, Cotteswold Hills.
LIASSIC	Upper Lias	Liassic Sands	Dundry, Midford, Frocester.
		Upper Lias Clay	Dundry, Midford, Frocester.
	Middle Lias	Marlstone	Dundry, Sodbury, Stinchcombe.
		Clays	Dundry, Sodbury, Stinchcombe.
	Lower Lias	Clays	Horfield, Pell.
		Limestones	Keynsham, Saltford.
TRIASSIC	Upper Trias	*Avicula contorta*	Aust, Beechum, Garden Cliff.
		Keuper	New River, Cotham.
		Dolomitic Conglomerate	Bristol, Portishead, Clevedon.
PERMIAN	- - -	- - - -	Absent.
CARBONIFLROUS	Upper	Coal Measures	Mangotsfield, Radstock, &c.
		Millstone Grit	Brandon Hill, Fish-ponds, &c.
		Upper Shales	Clifton, Ashton, Fish-ponds.
	Lower	Carboniferous Limestone	Clifton, Mendips, Tortworth.
		Lower Shales	Clifton, Clevedon, Tortworth.
DEVONIAN	Old Red	Sandstones	Clifton, Portishead, Mendips, &c.
		Conglomerates	Clifton, Portishead, Mendips, &c.
UPPER SILURIAN	- - -	Ludlow	Berkeley, Purton Passage.
		Wenlock	Tortworth, Falfield.
		Upper Llandovery	Tortworth, Damory.
IGNEOUS ROCKS	- - -	Greenstone	Damory, Charfield, Woodford.
		Basalt	Uphill, Mendips, Weston.

Devonian.—The Old Red Sandstone, in its upper parts, consists of fine-grained thin flagstones of a whitish-grey colour; and Tortworth Court is built of these fine building beds. This upper division is underlain by coarse quartzose conglomerates, and at the base by red sandstone, which rests on the Llandovery strata. The same succession of beds is very persistent, with conglomerate in the centre and lower third, and sandstone above and at the base.

Carboniferous.—The Bone Bed at the base of this formation is well developed, together with the Lower Limestone Shales. *Psammodus linearis*, *P. lævissimus*, Coprolites, and *Pileopsis angustus*, Phil., a shell of the Carboniferous Limestone, are the leading fossils here.

Millstone Grit and Coal Measures.—These beds have been fully and accurately described in the "Geological Transactions," by Weaver, Buckland, and Conybeare, accompanied by many valuable sections. They consist of Millstone Grit, Lower Coal Measures, Pennant Sandstone, and Upper Coal Measures; the whole series may be studied and examined in this district. A section constructed from Tortworth Green to Frampton Cotterell gives the following:—Tortworth Green, Old Red; the Court and Park, Lower Limestone Shales; Ley Hill and Cromhall. Carboniferous Limestone; Cromhall Heath, Millstone Grit; Sweethouse, Lower Coal Shales; Sweethouse to Robin's-wood House, Pennant, and from Robin's-wood House to Frampton Cotterell, Upper Coal Measures of the Coal-pit Heath basin.

An able paper on this subject, with Map and Sections, by my friend Mr. Etheridge,[1] F.R.S., will be found in the papers of the Cotteswold Club.

Dolomitic Conglomerate.—Weaver described this formation as composed principally of "rounded and angular fragments of limestone, exceeding the size of the head, with fragments also of quartz and hornstone. These are all cemented together by a calcareous paste, which is frequently of a marly nature—or of a carbonate of lime either of an earthy or compact structure;" the cement is generally magnesian, and in this there are many cavities frequently lined with crystals of calcareous spar and quartz, and also with the sulphate of strontian.

This remarkable formation forms a kind of irregular broken fringe, hanging on the flanks of the older rocks, and resting unconformably upon them. We shall meet with this conglomerate again in connection with the beds in the Mendip Hills, and in the Clifton section.

New Red Sandstone.—The upper and central members of the New Red Sandstone are found near Tortworth; they consist chiefly of red clay and marl.

Avicula contorta beds have been found by the Earl of Ducie in the form of the Bone Bed, the series resting on the inclined edges of the Carboniferous Limestone.

2. MENDIP HILLS.

The Mendip Hills proper extend from Bleadon Hill near Hutton on the west, to Elm and Whatley on the east; and they strike nearly due west and east, and are about thirty miles in length, with an average breadth of five to six miles. They constitute the southern base of the Bristol Coal Field, or the base of an almost equilateral triangle, formed by the Palæozoic rocks, comprising the area from Purton Passage and Tortworth to the south slopes of the Mendips; this includes the outlier Bream Down, which is only a westerly prolongation in the Severn, separated from the main range of the Mendips by the alluvial flat of the estuary of the Axe.

The Lithology of the Mendips consists of Old Red Sandstone, Carboniferous Limestone, and Trias, the latter represented chiefly by the Dolomitic Conglomerate, which lies unconformably on the Old Red and Carboniferous, flanking nearly the entire range of hills, and in places capping their summits.

Numerous islands of Carboniferous Limestone surrounded by Triassic rocks occur east of Wells and south of Croscombe, also encircled by fringes of Dolomitic Conglomerate, of which Church Hill, Worminster, and Knowl-foot Hill are examples; these outliers testify to the southern extension of the Carboniferous Limestone beneath the New Red Sandstone and Lias south of the Mendips, and lend us aid in determining the probable position of deep-seated Coal Measures similar to those at Vobster, Colford, Edford, Holcombe, &c., north of the Mendip range.

The lower flanks of the northern portion of the range are covered by the New Red Sandstone, that of the south being a mere strip traversed by the Wells and Axbridge Railway, the peat plains and bogs of Sedgmoor covering them up to a certain level to the east of the meridian of Glastonbury. The Lias occupies an extensive plain, masking likewise the older rocks beneath.

Old Red Sandstone forms the oldest stratified rock, and is, strictly speaking, the axis of the Mendip Hills. It is exposed in four well-marked areas along the highest ridge:—(1) Blackdown; (2) North Hill and Pen Hill; (3) Beacon Hill; and (4) Downhead Common, which is the largest exposed tract. The intervening areas are occupied by a mantle of Carboniferous Limestone, which arches over and covers the underlying Old Red, denudation having yet spared the limestone.

The Old Red is exposed along two anticlinal axes, these being, indeed, the chief cause of its exposure; the axes being post-Carboniferous and pre-Triassic, are not traceable beneath or where the patches of Dolomitic Conglomerate and cherty Lias cover up the Old Red Sandstone and Carboniferous Limestone, as at Harptree Hill, Rowham, Shipham, &c.

The most northerly anticlinal brings up the fine range of Blackdown, on the north, south, and east of which occur the Lower Limestone Shales resting on Old Red.

The northern dip of the anticlinal is higher than the southern, being in places as high as 54° in the north, whilst in the south it does not exceed 20°. This anticlinal is traceable from near the exposure of the igneous rock at Uphill, along Bleadon Hill, thence under the New Red Sandstone to Padingham, and Dolomitic Conglomerate and Calamine beds of Shipham, through the Old Red Sandstone of Blackdown, and on through the Carboniferous Limestone of Lamb-bottom, where it is lost under the cherty Rhætic beds of Harptree Hill. From Little Elm on the extreme east, to Masbury Castle nearly due west of the range, the Old Red is again exposed for three miles, which is likewise due to the anticlinal axis.

At Masbury Castle we lose trace of this S.E. anticlinal, and a second and parallel one to that of Blackdown occurs, ranging from the Old Red of North Hill through the Carboniferous Limestone of Stoke Warren, and last under the Dolomitic Conglomerate of North Draycott. This may join the great anticlinal near Egar Hill. We thus see that the strike of the Mendips was induced by a force which has brought out its oldest rock to the surface, and thereby produced the present physiography of the bold range of hills we are now considering.

Carboniferous Limestone surrounds the exposed and concealed nucleus of Old Red, and is conformable therewith both in dip and strike. The Carboniferous Limestone has grand development in the Mendips, and constitutes the great mass of the chain, having a continuous spread of five miles between Westbury Beacon and Abbey, also between Croscombe and Emberrow. The Lower Limestone Shales are nowhere more finely exposed than around and resting on the upper members of the Old Red Sandstone, and are highly fossiliferous throughout, the beds being crowded with *Strophomena*, *Chonetes*, *Spirifera*, Polyzoa, the ossicula of Crinoids, and many Trilobites, presenting a strong contrast to the barren beds of the Old Red on which they conformably rest. The Shales are well developed around Blackdown, especially to the east of Charterhouse, at Rowbarrow and Priddy, west of North Hill, and Nine Barrows; and east of Egar Hill they attain a thickness of 500 feet, and are extremely rich in organic remains. They present an extended outcrop from Masbury to Stoke Lane, and Leigh upon Mendip, and in the Downhead beds near Asham Woods. The local development of these argillaceous beds of the lowest division of the Carboniferous Limestone first gave origin to the name Lower Limestone Shales. They are almost special to the west of England, and are exposed on both flanks of the Mendip range. On them rest the thick-bedded strata of the Carboniferous Limestone, which is everywhere traceable for thirty miles from Oldford, the gorge of the Vallis to Elm on the east, to the distant headland of Bleadon in the west, and everywhere abounding more or less with organisms which form the leading fossils in its beds.

Coal Measures.—On the northern flank of the Mendips, between Binegar and Wells, and resting on the Millstone Grit, highly faulted and contorted, are the well-known Coals of Vobster, Holcombe, Pitcot, &c., that portion on the west at Stratton on the Fosse, Downside, &c. being covered by Dolomitic Conglomerate, the eastern side at Newbury and Vobster being overlain by the same rock and the Inferior Oolite. There is no reason why we should not conclude that the Coals of the northern side once extended across the Mendips and now lie deeply buried along the south parts of the range. At Ebber rocks, west of Wells, we have evidence of the Millstone Grit resting on the Carboniferous Limestone; and the elevation of the Mendips being post-carboniferous, lends an additional reason for the occurrence of the Coals of the northern area to the south of the Mendips, and beneath the Lias and Peat plain of Glastonbury, Castle Carey, the Pennards, and the Poldon Hills. No Coal area in the United Kingdom is so disturbed and folded both along its strike and on the dip of the Coals as those of North Mendips; and like the Coals of the "Mons Coal-field" in Belgium, which exists under similar conditions, the seams are vertical and thrown over, so that the same seams are passed through by shafts two or three times. The Vobster and Holcombe Coal-seams are the same as those at Ashton and Kingswood near Bristol, Twerton near Bath, and probably the same as those at Yate. They underlie the whole area between the Mendips and Bristol, and are probably the same that occur at Kingswood and underlie the Pennant at Coal-pit Heath.

The Trias.—Two divisions of this group are greatly developed around and upon the Mendips, especially the inferior or Dolomitic Conglomerate, a peculiar and local condition of the base of the Keuper Sandstone of the Bristol and South Wales Coalfields, chiefly that portion of the latter which extends from Cardiff to Bridgend. The entire range of the Mendips is surrounded by Dolomitic Conglomerate; and ten or twelve patches still remain as unconformable undenuded masses of that formation resting upon the older rocks forming the massive range of the Mendips. This remarkable deposit completely covered the range when at a lower level, its partial removal being conclusively shown by the remnants that still cling to the steep face of the northern and southern flanks of the Mendips.

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[1] Proceedings of the Cotteswold Naturalists' Field Club, p. 28, 1865.

This Conglomerate is composed entirely of greater or lesser fragments of the older rocks composing the hills, and is the result of the denuding action of the sea that deposited the Keuper beds. This marine denudation took place when the entire area occupied by the Mendips and Coal-basin underwent depression, the Dolomitic Conglomerate and sandstones accumulating *pro ratâ* with the depression and consequent destruction of the rocks offered for resistance. This conglomerate, the "*overlie*" of the coal-miners of the Bristol basin, although visible only upon the Palæozoic rocks surrounding the coal-bearing area, is nevertheless entirely spread over them, and beneath the New Red Sandstone that occupy nearly the entire area from Tortworth to the southern flanks of the Mendips, its presence being marked by the marls and sandstones of the Keuper, the Lias limestones, and in other places the Oolitic rocks that lie within the Coal-basin, especially along its south-east border from Bath to Wells. We have no physical evidence more convincing of denudation, elevation, and depression over large areas of the earth's surface than what we can witness so easily and study so advantageously in the Mendip Hills; for this conglomerate rock here defines the limits between Mesozoic and Palæozoic times: the highly inclined Old Red Sandstone forms the nucleus of the chain, the Carboniferous rocks resting upon it; and the Coal Measures in conformable succession to the latter were all indurated, metamorphosed, elevated, and thrown into folds long prior to the time when, under slow depression, destruction, and denudation, the Dolomitic Conglomerate was laid down by the Triassic sea—the resultant of wave forces along a coast-line which was then the Mendip range, its shingle and boulders being slowly cemented by a magnesio-calcareous paste derived from the wasting beds of the great limestone series. For further details regarding the natural history of the Dolomitic Conglomerate I must refer to a valuable memoir on this formation by Mr. Etheridge, F.R.S.[1]

The Rhætic.—Singular beds of cherty and sandy deposits of Rhætic age occur in several parts of the Mendips, in places brecciated, or as a conglomerate, and resting either upon the Dolomitic Conglomerate or Carboniferous Limestone.

The fossils are either cherty, or they have been removed, and their moulds are formed of chert, or cavities are left where organisms existed.

These beds are exposed at East Harptree, Egar Hill, Ashwick, and Shepton-Mallet. In the Vallis they repose immediately on the upturned edges of the Carboniferous Limestone, and even fill in the numerous veins, pockets, and faults in that formation, with fossil species common to the beds.

Nowhere can the geologist read more clearly the physical history of the groups of associated rocks composing the structure of the Eastern Mendips than at Wells, the Vallis, Watley, Elm, Nunny, and Holwell, where Old Red Sandstone, Carboniferous Limestone, Coal Measures, Dolomitic Conglomerate, Rhætic beds, Lias, and Oolites are all exposed in natural sequence to each other. There can be no doubt that the Rhætic sea surrounded and covered the Mendips; for its remains are found reposing on the Old Red Sandstone, Carboniferous Limestone. Coal Measures, and Dolomitic Conglomerate, and pass upwards into the Lias beds.

The Lias.—Fragmentary portions of this formation are found resting upon the summits of the Mendips, covering respectively Old Red Sandstone, Carboniferous Limestone, Dolomitic Conglomerate, and Rhætic beds, and in the Holcombe and Barrington districts resting upon the Coal Measures, proving the former extension of the Liassic sea over the Mendips; for upon some of their highest points, as near as Castle Comfort, the cherty beds, with their characteristic fossils, are found; also at Chewton Mendip, Emberrow, Ashwick, &c.; and on the south side of the hills it is found at a considerable height, as at Dowside, Chilcott, and West Herrington. During the Lias age the Mendips must either have been an archipelago, or they were totally submerged beneath the sea which deposited the Liassic plain to the north and south. The re-elevation of the Mendip range has occasioned the removal by aqueous denudation of most of the Lias beds deposited on their summit, whilst along the southern flanks of the hills, and in the valley, a considerable thickness of this formation still remains *in situ*.

Igneous Rocks.—Mr. Charles Moore[2] has shown that there is an exposure of basaltic rocks (dioritic) along the anticlinal of the Mendips, a little west of Downhead, extending visibly nearly as far as Beacon Hill, between two and three miles in length and a quarter of a mile in width.

This igneous mass appears in the form of a dyke, and is coincident with the anticlinal line along the axis of the Mendips, which is here traceable for seven miles, and is again continued from near Harptree to Shipham.

There is likewise at the south end of Uphill cutting (Bristol and Exeter Railway), at the western extremity of Bleadon Hill, an extensive patch of igneous rock, discovered when that line was made, and described by Mr. W. Sanders, F.R.S.; this exposure was also in the line of the anticlinal, and ended in the fault which there crosses the line. This rock, according to Mr. Rutley's analysis, is a Pitchstone Porphyry, whilst Mr. David Forbes considers it a Dolerite.

Whether this dyke was really eruptive or overflowed the Old Red Sandstone is still a question to be solved; and whether it is co-extensive with the range is unknown; but its age must be subsequent to the Coal Measures—the whole of the Palæozoic rocks being disturbed alike, and lying at one general angle of inclination, the overlying secondary strata not being influenced or at all affected by these Palæozoic changes. The Old Devonian rocks in contact with the dyke are not altered or metamorphosed, thus establishing the facts of age and condition.

3. THE RADSTOCK DISTRICT.

Among the many interesting features of the neighbourhood in which we are assembled is the Bristol Coal-field, which still offers an inexhaustible subject for scientific inquiry; extending from Cromhall in the north to Frome in the south, and from Bath in the east to Nailsea in the west, comprising an area of 238 square miles.

From a very early date it attracted the attention of geologists, and was long ago the subject of a paper by Mr. Strachey, which was published in one of the local societies. Dr. Buckland[1] contributed an able memoir on this Coal-field, in which a great quantity of important information was placed on record, which has been of the greatest possible use down to the present time.

Subsequently this area has formed the subject of able papers contributed to the North of England and South Wales Institutes of Engineers, by Mr. J. C. Greenwell, F.G.S., and Mr. Handel Cossham, F.G.S., and to other scientific societies by Mr. Robert Etheridge, F.R.S., and Mr. Charles Moore, F.G.S.

During the past twelve years Mr. J. M'Murtrie, F.G.S., of Radstock, has been continuously engaged in working out the physical geology of the district, and has contributed a series of memoirs on the Bristol Coal-field to the Bath and Somersetshire Societies, which have thrown a new and important light on these marvellous disturbances which have distorted the strata.

That part of the Report of the Royal Coal Commission bearing upon the Bristol Coal-field, and prepared by Professor Prestwich, and papers by Mr. Horace Woodward and Mr. John Anstey, have summarised our previous knowledge, and added recent facts thereto; but with all that has been done much remains to be investigated before a full history of the Bristol Coal-field can be written.

Although more or less connected throughout, the Coal-fields adjoining Bristol consist of three well-defined areas, called the Gloucestershire, Radstock, and Nailsea basins, each of which has its own distinctive features. The Gloucestershire is separated from the Radstock basin by the great Kingswood anticlinal, which intersects in a ridge-like form the entire Coal-field from east to west; and the Nailsea basin has been almost, if not entirely, cut off from the principal coal district by the elevated limestones of Broadfield Down. Of these three areas Radstock basin is the most extensive, both geographically and sectionally, a great portion of its thickness being yet entirely undeveloped. One of the features which will be remarked by visitors coming from other parts of England is the number and character of the Secondary formations by which the Radstock basin is overlain. Here and there, it is true, Mesozoic rocks have been denuded; but by far the greater portion of the Coal-field is hidden beneath a covering of New Red Sandstone, Lias, and inferior Oolite, and many of the shafts have had to pass through all these formations before the coal-seams were reached.

A very slight change in the geological circumstances of the past would have left us in entire ignorance of the existence of a Coal-field so far south as Bristol; and this reflection induces the hope that in other parts of the country (at present believed to be without coal, or, if present, to lie at such a depth from the surface that it cannot be worked) it may yet be discovered at a moderate depth.

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[1] Quart. Journ. Geol. Soc. vol. xxvi. p. 174 (1870).

[2] Ibid. vol. xxiii. p. 452 (1867).

[1] Trans. Geol. Soc. Second Series, vol. i.

Another feature of the Radstock Coal Measures is their great thickness, which Mr. M'Murtrie estimates at 8,000 feet. From this we may infer that, however limited the area in Somersetshire of which we have at present positive knowledge, we are very far indeed from the edge of that infinitely more extensive area which the Coal Measures of the South of England originally occupied, and within which outlying basins may still be found.

It is abundantly evident that the Bristol Coal-field was originally connected with that of the Forest of Dean and South Wales, with which it has many characters in common, although it differs in other respects.

In all we find the same arrangement of the different strata, namely:—1st, an upper division of productive Coal Measures; 2nd, a central mass of Pennant Sandstone; and, 3rd, beneath, a lower division of productive Coal Measures resting upon, 4th, the Millstone Grit. Hitherto it has been found impossible to correlate the seams of coal; but they present many points of general correspondence in the districts referred to; and the information obtained leads to the conclusion that their greatest sectional development occurs between Radstock and Bristol, according to the following estimate of the thickness of the strata, number of seams, and thickness of coal-seams:—

TABLE II.—Strata and Coal-Seams.

Division of Strata.	Sectional thickness.	Number of Coal-seams.	Thickness of Coal-seams.	
			Feet.	Inches.
Upper Coal Measures.....	2,600	16	26	10
Pennant Sandstone..........	2,750	4	5	10
Lower Coal Measures.....	2,800	26	66	6
	8,150	46	97	26

This great sectional thickness is attended, however, with serious disadvantages; for although, according to the Report of the Royal Coal Commission, the Bristol Coal-field was estimated to contain 6,104 millions of tons of coal, a large portion of it lies at an unworkable depth. Another physical feature of the district is the thinness of many of the seams from which coal is at present obtained.

In many of the collieries seams of from 10 to 12 inches in thickness are extensively worked, thus setting a good example of economy of one of our most precious natural productions to other parts of England, where veins of similar thickness are left behind as worthless.

Another feature of the Radstock Coal-basin is the extreme richness of its beds in the fossil flora of the Coal Measures. The Pennant Sandstone and Lower Measures yield few plants; but the Upper divisions contain much finer specimens than I have seen elsewhere, and the fossil flora of Radstock preserved in Mr. M'Murtrie's museum is alone worth a journey to study and admire. The fossil ferns are in great variety and beautifully preserved. The *Sigillariæ*, *Lepidodendra*, and other acrogenous stems tell of the arborescent ferns that floated their plume-like foliage on the islands of the Carboniferous period, and the industry and genius of the man who has collected and preserved them for our instruction and delight. The animal remains are here very scarce; two or three species of the genus *Limulus*, and one or two *Anthracosiæ*, are all that have been found; and I have the satisfaction of adding that I am authorised to say that by previous arrangement Mr. M'Murtrie will be happy to show his museum to any members of the Association to whom the same might be interesting. As there will be, I understand, memoirs on the Radstock Coal-field, I must refer to these papers for further details on this interesting district.

4. THE BRISTOL DISTRICT.

In a radius of eight miles from the Guildhall we find exposures more or less complete of the following Palæozoic and Mesozoic formations:—1. *The Old Red Sandstone*; 2. *the Carboniferous Limestone*; 3. *Millstone Grit*; 4. *Coal Measures*; 5. *Dolomitic Conglomerate and New Red Sandstone*: 6. *Rhætic*; 7. *Lias, Lower, Middle, Upper*; 8. *Upper Lias Sands*; 9. *Inferior Oolite*; 10. *Fuller's Earth*; 11. *Great Oolite*; 12. *Alluvium*, with igneous rocks of Palæozoic age. Several of these formations I have already noticed in speaking of the Mendip Hills; therefore I shall only now add such special remarks as are required to complete their sketch in the Bristol district.

The *Old Red Sandstone* forms, as we have seen, the axis of the Mendip Hills, and here occurs as a massive rock in different regions of the Bristol Coal-field, forming ranges of hills that have been sculptured by denudation out of its anticlinal folds. The beds in general are very unfossiliferous.

In the neighbourhood of Portishead, however, the remains of some large fishes have been found in a hard conglomerate, belonging to the genus *Holoptychius*—reminding us of the fishes of the Old Red Sandstone of Scotland, which were all encased in a bony armour, and possessed some of the most remarkable forms of the ichthyic type. *Pterichthys* or wing-fish, *Holoptychius* or wrinkle-scaled fish, *Cephalaspis* or buckler-shielded fish, are all forms of the Old Red, and the earliest representatives of the class Pisces in the Palæozoic rocks.

The Carboniferous Limestone is a great marine formation, and is formed of the sediments of an extensive and wide-spreading sea; the beautiful scenery so characteristic of the Avon, Severn, and Wye is in a great measure due to the development of this rock in these regions. One of the grandest sections of all the beds of the Carboniferous Limestone is that exposed in the gorge of the Avon near Clifton, where it is seen resting on the Old Red Sandstone, and overlain by the Millstone Grit.

The various conditions of the old sea-bottom in which this mass of calcareous rock was formed may here be studied with ease. The entire thickness of the strata exposed is upwards of 4,000 feet; of this the Old Red Devonian is 768 feet, the Carboniferous Limestone 2,338, and the Millstone Grit 950 feet. This magnificent section has repeatedly been the subject of memoirs by Buckland,[1] Conybeare,[2] Bright,[3] and Williams,[4] who have given ample details of all its different beds.

The Lower Limestone Shales, 500 feet in thickness, are very fossiliferous; they consist of alternations of shales and limestone, with a bone-bed near their base; in some places beds several feet thick are formed of the ossicula of Crinoids. In the main Limestone series you have a succession of Brachiopoda; *Spirifera*, *Producta*, and *Orthis* follow each other. Of Lamellibranchs we find *Aviculopecten*, *Cardiomorpha*, &c., with Gasteropods, as *Euomphalus* and *Bellerophon*, and Cephalopods, as *Goniatites*, *Orthoceras*, *Actinoceras*, &c. To these may be added the teeth and defensive spines of large shark-like and other fishes, as *Cladodus*, *Psammodus*, *Orodus*, *Holoptychius*, &c. Some of the coral strata in the upper part of the series are very interesting, and extremely rich in very beautiful specimens of Actinozoa, belonging to the reef-building groups of the ancient sea, as *Michelinia*, *Amplexus*, *Lithostrotion*, *Syringopora*, *Lonsdaleia*, &c., reminding us of the structure of coral reefs in our present seas. Associated with the coral masses are other organisms which lived on the reefs, or in shallow lagoons. The coral beds are covered by strata formed of Oolitic limestone and other detrital materials derived from the débris of wasted reefs, and formed along the shores of the ancient coral strand; sections of these oolitic beds prepared as slides for the microscope disclose the fact that the nucleus of the oolitic granules is often the shell of Foraminifera.

Millstone Grit is well seen at Brandon Hill; it rests upon the Limestone, and attains a thickness of 1,000 feet. On this repose the Coal Measures of the Bristol Coal-field, which I have already described in connection with the Mendip and Radstock districts.

Dolomitic Conglomerate.—The Palæozoic rocks of the Bristol Coal-field are here and there covered over by patches of Dolomitic Conglomerate lying unconformably on their upturned edges, at heights varying from 20 to 300 feet above the Avon. This remarkable formation is very well seen in the new road leading from the Hot-wells to Clifton and Durdham Down. It has been long well known to geologists, and was in former days described by Bright, Gilby, Buckland, and others.

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[1] "On the South-Eastern Coal District of England," Geol. Trans. 2nd series, vol. i.

[2] Geol. Trans. 1st series, vol. iv.

[3] "On the Limestone Beds of the River Avon," Geol. Trans. 1st series, vol. v.

[4] "Memoirs of the Geol. Survey," Sir H. De la Beche's Essay, vol. i. p. 113.

Rhætic.—Between the uppermost beds of the grey marls of the Keuper and the lowest beds of the Lias there lies a remarkable assemblage of strata, which I formerly described,[1] as the "*Avicula contorta* beds," from that shell forming the leading fossil therein. The name Rhætic has since been given to the series, from a supposition that the beds are identical with some that occur in the Rhætian Alps, which is, however, more than doubtful. Typical sections of the *Avicula contorta* series are exposed at Garden Cliff, Aust Cliff, Penarth, and Watchet on the Severn, and at Weston, Keynsham, Willsbridge, and Saltford near Bath, and Puriton, Uphill, and Wells in Somersetshire, as well as at many other localities. Two of the most classical of the series are Garden Cliff and Aust Cliff; the latter has been long known to continental geologists as the Bristol Bone-bed. In the upper part of the section are dark grey shales, intersected by bands of limestone; *Avicula contorta*, *Cardium*, *Rhæticum*, *Pecten Valoniensis*, *Axinus*, &c. are found in these. The Bone-bed consists of a hard dark-grey siliceous grit full of the bones, spines, scales, and teeth of fishes belonging to the genera *Nemacanthus*, *Acrodus*, *Sargodon*, *Hybodus*, *Ceratodus*, &c. Beneath this thin Bone-bed, with its ichthyic débris is a bed of shale which rests upon the grey marls of the Keuper. A similar succession of strata is repeated in most of the other typical sections. I have named especially those of Garden Cliff, Penarth, Uphill, and Watchet.

Aust has been long famous for its *Ceratodus* teeth, and is, I believe, the only locality where they are collected. You will find a fine series of them in the Bristol Museum. This wonderful collection is quite unique and will well repay an attentive examination.

The only living representative of the genus *Ceratodus* now lives in the rivers of Queensland; and a fine specimen was lately purchased for and presented to the Museum by W. W. Stoddart, Esq., F.G.S., for the purpose of showing the comparative size of the recent and fossil teeth.

5. DUNDRY DISTRICT.

The Oolitic Formations.—The Oolitic formations will long remain classical ground to English geologists, as it was whilst studying these rocks in Wilts and Somerset that Dr. William Smith first acquired that knowledge which enabled him to "identify strata by organic remains," and establish a true natural system of stratigraphical geology.

The Oolitic period admits of a subdivision into three groups—the Lower, Middle, and Upper; each group is based on a great argillaceous formation, on which rest minor beds of sands and cream-coloured Oolitic and Pisolitic limestones. The argillaceous formations form broad valleys, extending diagonally across England in a direction north-east by south-west. The limestones constitute low ranges of hills, with escarpments facing the south-west, and overlooking the valleys. The Lower Oolites rest on the Lias, the Middle Oolites on the Oxford Clay, and the Portland and Upper Oolites on the Kimmeridg Clays.

The *Lias Formation* is well developed around Bristol; and many interesting and instructive sections of the Lower beds may be studied at Horfield, Keynsham, Saltford, and Weston, whilst the Middle and Upper divisions are exposed in other localities. It has been often repeated of late years that the geological record is imperfect, and that many of the leaves, and even whole chapters of the Rock-book on which the hieroglyphics of its history were written, are wanting; yet "Time, which antiquates antiquities, and hath an art to make dust of all things, hath yet spared these minor monuments;" for it is certainly true that the Jurassic formations contain a marvellously complete record of the succession of life in time during their deposition from the dawn of the Lias until the close of the Coral Sea, amid whose islands fossil *Cycadeæ* luxuriantly flourished, and whose remains are buried in their native Dirt-beds in the Portland Oolites.

I have shown elsewhere that the three divisions of the Great Lias formations admit of several subdivisions or zones of life, each characterised by a group of species which individualise it. A careful examination of these subdivisions has further proved that there is no confusion in the rocks when carefully examined—that Nature is always true to herself, although all geologists are not true to Nature. The fossils of the Lower Lias are quite distinct from those of the Middle Lias, and both specifically different from those of the Upper.

The *Ammonites* are important leading Liassic shells, that appear to have had a limited life in time, but a wide extension in space; and they have greatly aided us in determining periods and making out the history of the Liassic sea. The great SAUROPTERYGIA, represented by the *Plesiosaurus*, and the ICHTHYOPTERYGIA by the *Ichthyosaurus*, are remarkable forms of Reptilia, adapted to the waters of that epoch, whilst the DINOSAURIA, represented by *Scelidosaurus*, the PTEROSAURIA by the *Pterodactylus*, lived in this area during the Lias age; magnificent specimens of these different forms of reptiles adorn the walls of the Bristol Museum.

The Jurassic Age.—Dundry Hill, 700 feet in altitude, is the most westerly outlier of the Oolitic range, from which it is nine miles distant. It is a locality of great interest to the local naturalist, as it affords capital lessons of stratigraphical geology, admirable examples of surface-rock sculpture by denudation, and a commanding point of view for surveying the same, and showing the grand panorama in the midst of which it stands. The greater portion of the hill is composed of Lower Lias strata, which are well exposed at Bedminster Down, Whitchurch, Keynsham, Queen Charlton, Norton, Malreward, Winford, and Barrow. The beds consist of alternations of limestones and shales, having a total thickness of 550 feet. The Middle Lias and Marlstone are feebly developed, and the Upper Lias represented by some thin clays, with dwarfed specimens of *Ammonites bifrons* and *A.communis*; and the Upper Lias sands, from one to two feet thick, are not fossiliferous. On these rest beds of Inferior Oolite rock which have long yielded a very fine series of organic remains, some of the best of which are now preserved in the Museum collection. The Inferior Oolite of the south of England admits of a subdivision into three zones of life: the *Lower* resting upon the Lias sands has the *Ammonites Murchisonæ* as its leading fossil; the *Middle* contains a large assemblage of Mollusca, and especially of *Ammonites*, among which *Ammonites Humphriesianus*, *Sowerbyi*, *concavus*, and *Blagdeni* are conspicuously characteristic; the *Upper* contains *Ammonites Parkinsoni*, *Martinsii*, and *subradiatus*, with many Echinoderms and a large series of reef-building chorals. These three subdivisions are rarely all developed in the same section; but the order of their sequence in nature is as stated in Dundry. The lower beds are feebly represented; and there is an immense development of the middle and upper divisions.

In the iron shot shelly beds there is a fine assemblage of Lamellibranchs; and the stratum which covers them is very rich in Ammonites, many with their shells preserved, and having their oral lobes and other appendages *in situ*.

These are succeeded by other conchiferous strata; and the whole is covered by Ragstone and Building-stone, forming the upper zone, with *Ammonites Parkinsoni*, *Echinidæ*, and Corals. The stratigraphical, lithological, and palæontological conditions seen in the Oolitic capping of Dundry Hill, are repeated in other localities in Gloucestershire, Somersetshire, and Dorsetshire; and a full development of all the zones in actual superposition may be examined in certain sections in the Cotteswold Hills, as at Leckhampton and Cleeve.

The Fuller's earth must be studied at North Stoke and Lansdown, and the Great Oolite at Coombedown, Lansdown, and other localities around Bath; the typical Bradford Clay, with Apiocrinital heads and stems, and beautiful Brachiopoda near Bradford; the Forest Marble and Cornbrash at Faulkland, Chickwell, Marston Bagot, and Cloford. The Middle Jurassic rocks are admirably exposed near Calne, and the Upper Jurassic near Swindon, Wilts.

The great importance of the Bristol district as a source of mineral wealth, added to the complicated structure of this region, led my old friend Mr. William Sanders, F.R.S., to construct an elaborate geological map of the Gloucestershire and Somersetshire Coal-fields and adjacent country, on the scale of four inches to a mile. The topographical portion of this undertaking was reduced to one scale from the Tithe-Commission Maps; and Mr. Sanders traced out all the geological boundary lines in the field, and laid them down in MS. copies of the Tithe Maps, making copious notes of the strata as he proceeded with his work. The whole was finally reduced to one scale four times the size of the Ordnance-Survey Maps, and reproduced with the most scrupulous care by Mr. Stratton, who for many years assisted Mr. Sanders with the work which he had made the chief object and occupation of his later life; and it is but simple justice to say that, single-handed, no such exact map for any one area was ever before constructed, either as regards scale or details. This undertaking occupied its author 15 years, fills 19 separate folio maps, and is a most valuable acquisition to the estate-agent, mineral engineer, and practical geologist. Its real merits can only be fully appreciated by those who understand how much patient labour, long-sustained energy, and high mental qualities were required to complete so extended a survey over such a complicated piece of country. In doing this, however, Mr. Sanders has made his scientific reputation, enriched his native country, and achieved a success which falls to the lot of few men. Having considered the stratigraphical relation of the rocks in the Bristol district, I desire now to say a few words on a branch of the subject which falls more immediately within the range of my own special studies—I mean the organic remains found imbedded in these strata. The science of Palæontology (*palaios*, old; *onta*, beings) forms an immense field of observation, and one that widens more and more every year. It is impossible to enter upon any of its details now; but some of its principles may be satisfactorily explained, and this I shall endeavour to do.

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[1] Quart. Journ. Geol. Soc. vol. xvi p. 374.

It is now established, 1st, that the stratified rocks containing organic remains admit of a division into four great groups, representing four great periods of time:—*a*, the Palæozoic or Ancient; *b*, the Mesozoic or Middle; *c*, the Cainozoic or Tertiary; and *d*, the Quaternary or Modern periods. 2nd. That each period is distinguished by its own hieroglyphic characters, which are graven on the rocks in definite and determinable characters. 3rd. That these hieroglyphics are the fossil remains or imprints of animals that lived in the water in which the sediments were formed in successive layers on the earth's crust, and are only found in the rocks they distinguish, so that it is possible to determine the age and position of the strata from which they have been collected, or, in other words, *identify strata by organic remains;* and by this key we are enabled to read the pages of the Rock-book, study the history of extinct forms of life, and determine their distribution in time and space.

Let us apply these principles to the subject we have in hand. The Palæozoic period comprises the history of the Cambro-Silurian, Devonian, Carboniferous, and Permian ages; and if we attentively examine the fossils of this period, contained in the cases of the magnificent Geological Museum of this institution, we shall see that all the organisms belonging to one age are entirely distinct from those belonging to the others. You will find, for example, in the case of the Silurian age, some beautiful corals, crinoids, and cephalopods, with a remarkable assemblage of Crustacea, the representatives of an extinct family, the Trilobitidæ, which are so highly characteristic of this age that the rocks may be called Trilobitic.

The Devonian age succeeds the Silurian; and among the corals and shells so well seen in this collection, we observe a striking resemblance to those of the Silurian on the one side and the Carboniferous Limestone on the other; but when closely examined we find that many are generically, and all are specifically distinct from both; besides this we discover that a new group of organisms of a different and higher type of structure are now introduced for the first time, namely, those remarkable forms of the ichthyic class the fishes of the Old Red Sandstone, and whose singular forms with their bony armour and osseous scales remind us of the remarkable fishes *Lepidosteus* and *Polypterus*, from North American, African, and Australian rivers of our time. The hieroglyphics, therefore, engraven on the strata of the second age are visibly different from those on the first.

The Carboniferous succeeds the Devonian; and here we find a marvellous development of the life of this age preserved in the cases of this institution. Pray study attentively the fine specimens of Anthozoa here exhibited, all derived from the upper beds of the Carboniferous Limestone at the gorge of the Avon, and showing very clearly that this portion of the section was formed in a tropical sea, and that the limestone is the product of the living energies of those Polyps, sections of whose skeletons lie there before you. Of the family FAVOSITIDÆ we see *Favosites*, *Alveolites*, *Syringopora Michelinia;* and of the family CYATHOPHYLLIDÆ we have *Cyathophyllum*, *Lithostrotion*, *Lonsdalia*, &c. Many of the beds of limestone are almost entirely composed of the ossicula of Crinoids; and we see the stems, arms, and calyces of these sea-lilies strewed in abundance in the rocks, such as *Actinocrinus*, *Poteriocrinus*, *Platycrinus*, *Cyathocrinus*, *Pentremites*, &c., with the remarkable ancient Sea-urchin *Palæchinus* associated with them. The Mollusca were chiefly represented by the Brachiopoda, which were very common in the Carboniferous age, as you may see in the large slabs containing *Orthis*, *Spirifera*, and *Productus* in great profusion. The Lamellibranchiata were represented by *Cardiomorpha* and *Conocardium*, and the Gasteropoda by *Euomphalus*, *Pleurotomaria*, and *Natica*, and the Cephalopoda by *Goniatites*, *Orthoceras*, &c. The Trilobites which formed so remarkable a feature in the fauna of the Silurian sea are here represented by a few specimens of *Phillipsia*, a dwarfed genus of this family. The fine collection of teeth and spines of large fishes from the Carboniferous Limestone enables us to compare the forms of this age with those of the Devonian already described, and shows at a glance that the ichthyic types in the seas of these two periods were entirely distinct, and both evidently adapted to conditions of existence widely different.

The life of the Carboniferous Limestone proves that it was a great marine formation accumulated during a long lapse of time out of the exuviæ and sediments of many generations of Mollusca, Echinodermata, and Actinozoa, the reef-building corals having contributed largely to the thickness of the Coral beds, and the wasted reefs of former generations having been used up again and again in the formation of the Oolitic beds which succeeded the reef-building periods.

The Coal Measures present a remarkable contrast to the Coral sea of the Carboniferous era. The Ferns (*Sigillaria*, *Lepidodendra*) and other arborescent Acrogens of the Coal-seams grew and flourished in low islands; and their remains were accumulated under conditions very different from those in which the thick-bedded limestones of the Avon section were formed. Good typical examples of the vegetation of this remarkable time in the world's history are well preserved in the large collection, filling several cases; these specimens are all very fine, and require, and I am sure will have, a careful examination.

With the close of Palæozoic time there appears to have been a great break in stratigraphical sequence of the fossiliferous rocks; mighty changes then took place. Volcanic agency was intense and active, flexing, contorting, and upheaving the older beds. These displacements in our area were post-carboniferous and pre-triassic, and are well exemplified in the unconformable position of the Dolomitic Conglomerate and New Red Sandstone of the Bristol district.

The Dolomitic Conglomerate contains the bones of Dinosaurian reptiles discovered in Durdham Down, and preserved in this Museum; they were described by Dr. Riley and Mr. Stuchbury in 1836,[1] and were then the oldest Dinosauria in Britain. Since that date the Triassic sandstones of Cheshire, Scotland, and North America have been found to contain the foot-imprints of *Cheirotheria*, and the same formation near Warwick the bones and teeth of remarkable reptiles belonging to the family *Labyrinthodontia;* subsequently it has been discovered that the coal-field of Münster-Appel in Rhenish Bavaria, and that of Saarbrück between Strasburg and Trèves, contain the skulls and bones of several species of air-breathing reptiles which were described by Goldfuss under the generic name *Archegosaurus*. The reptilian remains of the conglomerate, though now not the oldest of their class, still retain their interest for the Palæontologist, as they prove that highly organised Dinosauria lived on Triassic land. I must refer you to the original memoir for a full account of these bones, which enabled its authors to establish two genera for them. The one, *Thecodontosaurus*, has the teeth placed closely together in the jaw-bones. They are sharp, conical, compressed, and have their anterior and posterior borders finely denticulated, and the extremity slightly bent, like the teeth of *Megalosaurus*. *Palæosaurus* has the teeth compressed and pointed likewise; but one of the borders only is denticulated, and the other trenchant. The species are distinguished by the size and form of the teeth. The vertebræ resemble those of *Teleosaurus* in being contracted in the middle, and having their articular surfaces slightly biconcave; and the rest of the bones of the skeleton resemble the forms of the Lacertian type.

We know very little of the life of the Trias in the district under consideration, beyond the reptilian remains first noticed here, until we come to the close of this age, when we find upper grey marls of the Keuper overlain by and passing into a series of black shales and limestones known as the *Avicula contorta* or Rhætic beds, which have a great interest for us, as they comprise the famous Bone-bed of Aust Cliff known to all geologists. The leading fossils are *Avicula contorta*, *Cardium Rhæticum*, *Monotis decussata*, *Pecten Valoniensis*, and the small crustacean, *Estheria minuta*. The fishes are *Nemacanthus*, *Saurichthys*, *Hybodus*,

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[1] Trans. Geol. Soc. 2nd series, vol. v. p. 349 (1840).

Gyrolepis, *Sargodon*, and *Ceratodus*, with bones of *Plesiosaurus* and *Ichthyosaurus*. It is the teeth of *Ceratodus*, or horned teeth, that have made Aust Cliff famous; and more than 400 different forms have been described. Mr. C. T. Higgins made the finest collection of these remains, which has been purchased for the Museum, and forms one of its rarest treasures. When these horned teeth, so called from the prominences they exhibit, were first described by Agassiz, the living species of this genus was not known; it is now ascertained that it lives in the Mary, Dawson, and other rivers of Queensland, and is called by the natives "Barramanda." The *Ceratodus* is very nearly allied to the *Lepidosiren*, is cartilaginous, a vegetable-eater, and, like the *Lepidosiren*, lives in muddy creeks; during the hot season it buries itself in the mud, whence it is dug up by the natives, its retreat being discovered by the air-hole through which it breathes; its nostrils are placed in the inside of the roof of the mouth.

A very interesting paper on *Ceratodus Fosteri* (the specimen in the Museum) by Mr. Stoddart, F.G.S., will be found in the "Proceedings of the Bristol Naturalists' Society," vol. i. p. 145.

The Lias, which succeeds the *Avicula contorta* beds, presents a remarkable contrast to them, and shows how much the life-conditions of every age depend on the physical agents that surround it. Two groups of animals appeared in great force in the Liassic sea—Ammonites and Reptiles.

The Ammonites of the Lower Lias beds, *A. angulatus*, *A. Bucklandi*, *A. Conybeari*, and others, attained a large size; and the middle and upper divisions of the same formations were all characterised by different species that marked horizons of life in these divisions. Associated with the Ammonites a large assemblage of other Mollusca are found, as *Gryphæa*, *Lima*, *Unicardium*, *Pholadomya*, *Cardinia*, *Hippopodium*, *Pleurotomaria*, and a profusion of Belemnites and large *Nautili*.

The Reptiles were very large, as you can see by the fine specimens on the walls: *Ichthyosaurus* and *Plesiosaurus* were the dominant forms of this class; and Pterodactyles with expanded wings performed the part of birds on the dry land of that era; so that the air, the estuary, and the ocean had each separate forms of Reptile life in the Lias age. Another change of conditions introduces us to new forms in the Lower Jurassic sea. A large number of species of Conchifera and Gasteropoda crowd the shelly beds of the Inferior Oolite; and new forms of Ammonites appertaining to groups entirely different from those of the Lias are found in abundance in Dundry Hill. In addition to the Mollusca we find many beautiful forms of Echinodermata, and a large collection of reef-building corals in the upper beds of the hill. Nothing gives us a clearer insight into the fact that all fossil species had a limited life in time than the distribution of the Echinodermata of the Jurassic strata, inasmuch as these animals possess a skeleton of remarkable structure, on which generic and specific characters are well preserved; they form, therefore, an important class of the Invertebrata for the study of the life-history of species in time and space; and this Table of the stratigraphical distribution of the Jurassic Echinoderms which I now exhibit reduces these observations to a practical demonstration.

The Oolitic rocks were formed in a coral sea analogous to that which rolls its waters in the Pacific between 30° on each side of the equator. In the Lower Oolites are four or five Coral formations superimposed one above another, with intermediate beds of Mollusca. The Middle Oolite is remarkable for the number and extent of its coral reefs, and the Upper Oolite for those found in the Portlandian series.

The Jurassic rocks were accumulated as sediments or shore-deposits under many changes of condition; and the idea of a slowly subsiding bed of the coralline sea gives us, perhaps, the nearest approach to what appears to have prevailed.

The Jurassic waters were studded with coral reefs, extending over an area equal to that of Europe, as they stretch through England diagonally from Yorkshire to Dorsetshire, through France from the coast of Normandy to the shores of the Mediterranean, forming besides a chain winding obliquely through the Ardennes in the north to Charente-Inférieure in the south, including Savoy, the Hautes-Alpes and Basses-Alpes, the Jura Franche-comté, the Jura chain of Switzerland throughout its entire length from Schaffhausen on the Rhine to Cobourg in Saxony, and along the range of the Swabian Alps and Franconian Jura. Throughout all this widely extended Oolitic region, coralline strata were accumulating through countless ages by the living energies of Jurassic Polypifera, as all the Madreporic limestone beds in these formations are due to the life-energies of different species of Anthozoa; and were we to venture to estimate the lapse of time occupied in the sedimentation of the coralligenous Oolites by what we know of the life-history of some living species, we should find good reasons for concluding that the Jurassic age must have been one of long duration. It is not the mere coralline structure *per se* that is due to Polyp-life, but the entire mass of Oolitic limestones are the products of the same vital force; for there could be no doubt in the mind of any competent observer who carefully examined such a rock as that in my hand that it was a mass of coral secreted by a Jurassic polyp, and that the Oolitic limestone which surrounds the coral stem is the product of a portion of a wasted reef which had been broken up, ground into mud, and constituted the calcareous paste that had coated particles on the shore, and formed by the roll of the waves the oolitic globules which were afterwards cemented by calcareous waters, and the whole transformed into the rock we call Oolitic limestone; and thus the genesis of the Oolites was due to the vital energies of the myriads of polyps that lived in the Jurassic seas.

The reefs that remain are merely fragments of what had existed; and those that have disappeared furnished the calcareous material out of which the Oolites of subsequent formations have been built up.

I have to thank my old friend Mr. Etheridge for the valuable notes he has supplied on the Mendip Hills (which he knows so well), and to Mr. M'Murtrie for his excellent notes on the Radstock district (which he has so long explored), and to Mr. Stoddart for kindness and assistance in many ways. Without their friendly co-operation it would have been impossible for me to have given so much exact information on the structure of the interesting and complicated region in which we have again assembled.

In these remarks I have carefully avoided any allusion to the origin of species, because Geology suggests no theory of natural causes, and Palæontology affords no support to the hypothesis which seeks by a system of evolution to derive all the varied forms of organic life from pre-existing organisms of a lower type. As far as I have been able to read the records of the rocks, I confess I have failed to discover any lineal series among the vast assemblage of extinct species which might form a basis and lend reliable biological support to such a theory. Instead of a gradation upwards in certain groups and classes of fossil animals, we find, on the contrary, that their first representatives are not the lowest, but often highly organised types of the class to which they belong. This is well illustrated in the Corals, Crinoids, Asteriadæ, Mollusca, and Crustacea of the Silurian age, and which make up the beginnings of life in the Palæozoic period. The fishes of the Old Red Sandstone we have already seen occupy a respectable position among the Pisces; and the Reptiles of the Trias are not the lowest forms of their class, but highly organised Dinosauria. *Ichthyosaurus*, *Plesiosaurus*, *Pterodactylus*, *Teleosaurus*, and *Megalosaurus* stand out in bold relief from the Mesozoic strata as remarkable types of animal life that were specially organised and marvellously adapted to fulfil important conditions of existence in the Reptilian age; they afford, I submit, conclusive evidence of special work of the Great Designing Mind which pervades all creation, organic and inorganic. In a word, Palæontology brings us face to face with the Creator, and shows us plainly how in all that marvellous past there always has existed the most complete and perfect relation between external nature and the structure and duration of the organic forms which gave life and activity to each succeeding age.

Palæontology likewise discloses to our feeble understanding some of those methods by which the Infinite works through natural forces to accomplish and maintain His creative design, and thereby teaches us that there has been a glorious scheme, and a gradual accomplishment of purpose through unmeasured periods of time; but Palæontology affords no solution of the problem of creation, whether of kinds, of matter, or of species of life, beyond this, that although countless ages have rolled away since the denizens of the Silurian beach lived and moved and had their being, the same biological laws that governed their life, assigned them their position in the world's story, and limited their duration in time and space, are identical with those which are expressed in the morphology and distribution of the countless organisms which live on the earth's surface at the present ttme; and this fact realises in a material form the truth and force of those assuring words, that the Great Author of all things, in these His works, is the same yesterday, to-day, and for ever.

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THIS year's session of this Association was opened last Thursday at Nantes, under the presidency of M. d'Eichthal, who is largely connected with French railways. The income of the Association for 1874 was 37,126 francs, and its capital fund amounts to 174,731 francs. In 1874, 5,350 francs were distributed for purposes of research, and already, owing to the generosity of three of the foundation members, 7,000 francs have been allotted to other purposes without trenching on the regular resources of the Association. This year 13 foundation members and 500 annual members have been added to the Association.

The President in his opening address spoke of the intimate connection between pure science and the various methods employed to satisfy the wants of humanity. It would be almost impossible, he said, to enumerate all the branches of human activity which owe their success to the researches of pure science,—Hygiene, Medicine, Surgery, the Fine Arts, Mechanics, Industry in all its branches, Mining, Metallurgy, Textile Industries, Lighting, Warming, Ventilation, Water Supply, &c. He then referred in detail to several examples of the influence which the results of science have had upon progress in the arts, with the motive forces of water, air and steam, mentioning a multitude of names of men eminent in pure science, from Pascal and Boyle down to Faraday and Sir William Thomson, upon the results of whose researches the great advances which have been made in machinery of all kinds have depended. M. d'Eichthal then spoke of electricity in connection with the names of Oerstedt, Ampère, Faraday, Becquerel and Ruhmkorff; passing on to speak at some length of the steam-engine in its various forms, of the progress which by means of scientific research is being made in its construction and its uses, and of the great services which this powerful application of a scientific discovery renders to man. M. d'Eichthal advocated the establishment of local centres of culture as the best counterpoise to that over-centralisation to which France owes so many of its social misfortunes. "In our time," he said, "science, history, literature, have great wants. Libraries, lecture-halls, laboratories, costly materials, instruments numerous and expensive, are indispensable to pupils for learning and to teachers for carrying on their researches; it is by putting, on a large scale, these resources at their disposal, that we can attract and fix in our midst men eminent in all branches of human knowledge."

M. Ollier, the General Secretary of the Association, gave a detailed *résumé* of the work done at Lille last year.

M. d'Eichthal has been very well received in Nantes, having been greeted with a serenade on Wednesday night.

The most notable foreigner present at the meeting, Admiral Ommaney, was elected, *pro honore*, president of the Geographical Section. The Geographical Congress of Paris has evidently diminished the attendance at the Nantes meeting, although M. Dumas and M. Wurtz have displayed on its behalf a most creditable zeal. Two ladies delivered addresses, on "Female Condition," and the "Sanitary Condition of Schools;" rather a novelty in France, ladies very rarely appearing as lecturers.

The excursions, which are by far the most interesting part of the proceedings, began on Saturday. A balloon ascent is contemplated for to-day. The balloon will be exceptionally large, 4,000 metres, conducted by local aëronauts who have organised an aërial sporting club.

NOTES

AMONGST the objects which have been recently added to the galleries of the Paris Industrial Exhibition of Geography, and are attracting public notice, we may mention a collection of French birds exhibited by M. Bouvier, the collection of apes from the Gaboon, by the Marquis de Compiègne, and a number of antediluvian fossils from the Mentone Caves. The skeletons of two children which had been buried together are in a splendid state of preservation, exhibiting admirably the characteristics of prehistoric cave-life. These two young people were buried in the home of their parents, very probably because it was the only means of defending their bones against the teeth of ferocious hyænas and other large carnivorous animals which were disputing with man the empire of the future Gaul. The bones were covered with small shells, of which the loin cloth of the departed youngsters had been made. Neither of them had any ornaments in bone, jasper, or pearl, such as is generally discovered under similar circumstances when the skeleton is that of an adult. No child is buried with such objects in Polynesian islands, as none are allowed to wear them even when belonging to the regal families.

IN connection with the Exhibition and Congress, it is believed that a series of proposals will be made to the French National Assembly for the promotion of the study of geography. The principal and most effective is to have a relief map of each parish in the parish school, so that pupils may learn to understand the purpose of geographical maps.

THE large reflecting telescope at the Paris Observatory is completed, although it will not be brought into use for two or three months. The equilibrium of the tube is perfect, and it can be directed with the utmost facility on any part of the heavens, although it weighs about six tons.

THE Commission appointed by the Prefect of the Seine for deciding on the improvements to be introduced in the construction of lightning conductors have just published their report. They are of opinion that the conductors should terminate in a point of copper instead of platinum as recommended by the Academy, and propose to institute an annual inspection of lightning conductors, as recommended by M. Wilfrid de Fonvielle in his pamphlet, "Lightning Conductors and the necessity of controlling them." A series of measurements will be presented to the Municipal Council in the next session. The inspection is to take place in autumn, when the stormy season is over.

THE annual provincial meeting of the Iron and Steel Institute will commence, in Manchester, on Tuesday, September 7, under the presidency of Mr. William Menelaus. The Council of Owens College have granted the use of that building for the business meetings. On Tuesday, the Mayors of Manchester and Salford respectively will welcome the members of the Institute, and the remainder of that and Wednesday morning will be devoted to the reading and discussion of papers. On the afternoons of Tuesday and Wednesday, various works in the neighbourhood of Manchester will be open for inspection. On Tuesday evening there will be a conversazione in the Town Hall; on Wednesday evening the members will dine together in the Hulme Town Hall; and on Thursday they will visit works within easy reach of Manchester. On Friday, the whole day will be devoted to North Staffordshire.

DURING last week the British Archæological Association made frequent excursions to places around Evesham, and in the evenings a number of papers were read, mostly of strictly antiquarian interest. The Cambrian Archæological Association also held its annual meeting last week at Carmarthen, both meetings being brought to a close on Saturday. Next year the latter body meets at Abergavenny under the presidency of Mr. Freeman.

MR. HENRY WILLETT, writing with reference to the Sub-Wealden Exploration, states that the committee have "succeeded beyond their fondest anticipations in solving the original problem, and can now state with certainty that palæozoic rocks do not exist at a depth variously estimated at from 700 ft. to 1,700 ft." From 1,670 ft. to 1,750 ft.—the depth now reached—the strata are shattered and very soft, greatly retarding the work, and seriously imperilling any prospect of attaining a much greater depth. Although at any moment a change of strata may be reached, Mr. Willett is not sanguine that he ever will be able to report more than that Kimmeridge clay has been discovered in Sussex, and that this clay is very thick.

An interesting geological discovery has been recently made during excavations for a new tidal basin at the Surrey Commercial Docks. On penetrating some 6ft. below the surface, the workmen everywhere came across a subterranean forest bed, consisting of peat with trunks of trees, for the most part still standing erect. All are of the species still inhabiting Britain; the oak, alder, and willow are apparently most abundant. The trees are not mineralised, but retain their vegetable character, except that they are thoroughly saturated with water. In the peat are found large bones, which have been determined as those of the great fossil ox (*Bos primigenius*). Fresh-water shells are also found. No doubt is entertained that the bed thus exposed is a continuation of the old buried forest, of wide extent, which has on several recent occasions been brought to the daylight on both sides of the Thames, notably at Walthamstow in the year 1869, in excavating for the East London Waterworks; at Plumstead in 1862-3, in making the southern outfall sewer; and a few weeks since at Westminster, on the site of the new Aquarium and Winter Garden. In each instance the forest-bed is found buried beneath the marsh clay, showing that the land has sunk below the tidal level since the forest flourished.

We have received a "Catalogue of the publication of the U.S. Geological Survey of the Territories, F. V. Hayden, Geologist in Charge." The catalogue covers twenty pages, and although the publication extends only from 1867, they already form quite a large library of reports, monographs, catalogues, &c., relating to all branches of the geology, natural history, meteorology, and other points of the extensive region which is being surveyed. The publications of the survey, we believe, Dr. Hayden is willing to send to any societies, libraries, or persons engaged in active scientific investigation who may desire them; those who do should communicate with Dr. Hayden, U.S. Geologist, Washington, D. C. (U.S.) Dr. Hayden is desirous of securing by exchange the publications of foreign countries in geology, palæontology, and natural history generally, to aid in the formation of a library of reference for the use of the Survey, and he hopes that all persons or societies who receive the publications of the Survey will aid him in this matter.

Vol. iv. of the second series of the *Mémoires* of the Royal Society of Science of Liége, contains only three papers, one of them a mere note of two pages on a new species of Lepidotus, *L. mohimonti*, by Dr. T. C. Winkler. The other papers are long treatises, one by Dr. E. Candèze, being a "Revision of the Monograph of the Elateridæ" (218 pp.), and the other a treatise "On the Calculus of Probabilities," by the late A. Meyer, published from the MSS. of the author by F. Folie (446 pp.)

Mr. J. Wood-Mason, of the India Museum, Calcutta, has lately directed attention to the presence of a chain of superorbital bones in the wood partridges (*Arboricolæ*), similar to that recorded by Mr. W. K. Parker in the tinamous.

The fourth number of the *Bulletin de la Société Impériale de Naturalistes de Moscou* contains papers on entomology, botany, geology, &c., by M. V. Motschoulsky, M.A. Petrovsky, M. H. Trautschold, and others, in the French and German Languages.

The Cincinnati Society of Natural History has lately received a bequest of $50,000 from Mr. Charles Bodman, of that city. The gift is absolute and without conditions.

A large meteor was observed at Niort (Deux-Sevres), on August 19, at 8.20 P.M. Although the moon was quite full, it was a magnificent spectacle. It made its appearance in the zenith, lasted thirty seconds, and disappeared in the south-east at an altitude of sixty degrees above the horizon. It must have been seen from other parts of France, but no record has come under our notice.

A chair of Organic Chemistry has been created in the Faculty of Sciences of Paris.

The additions to the Zoological Gardens during the past week include two Kinkajous (*Cercoleptes caudivolvulus*) from British Honduras, presented by Mr. James Wickin; a Central American Agonti (*Dasyprocta punctata*), two Brown Gannets (*Sula fusca*) from Costa Rica, presented by Mr. J. C. Hussey; a Woodford's Owl (*Syrnium woodfordi*) from Natal, presented by Mr. W. E. Oates; a Purple-capped Lory (*Lorius domicella*) from Moluccas, presented by Mr. T. P. Medley; a Mexican Guan (*Penelope purpurascens*) from Central America, presented by Mr. A. Warrington; two Gordon's Terrapins (*Platemys gordoni*) from Trinidad, presented by Mr. Devonish; a Tiger (*Felis tigris*) from India, a White-thighed Colobus (*Colobus bicolor*) from W. Africa, a West Indian Agonti (*Dasyprocta antillensis*) from St. Vincent, deposited; a Blotched Genet (*Genetta tigrina*), and two Crested Pigeons (*Ocyphaps lophotes*) bred in the Gardens.

SCIENTIFIC SERIALS

The *Naturforscher* for July contains the following among other papers:—On the distribution of land and water in Northern Europe during the ice-period, by K. Pettersen.—On the diffusion of gases through thin layers of liquid, by Franz Exner.—On Helmholtz's theory of vowels, by E. von Quanten.—On the influence of the surface of di-electric bodies upon their action at distances, by Romich and Fajdiga.—On electrodes which cannot be polarised, by A. Oberbeck.—On the changes of colour in an alcoholic solution of cyanine, by El. Borscow. Cyanine is the blue colouring matter of the flowers of *Ajuga reptans* and *A. pyramidalis.*—On the determination of alcohol in wine, by M. Malligand.—On the action of a weak acid upon the salts of a stronger, by H. Hübner and H. Wiesinger.—On the influence of the season upon the skin of embryos, by Herr Dönhof.—On the action of electricity of high tension upon liquids, by G. Planté.—On the motion of the imbibition water in wood and in the vegetable cell, by Julius Wiesner.—On a simple means to find the poles of a rod magnet, by F. Müller.—On the analysis of Japanese bronzes, by E. J. Maumené.—On the nutrition of the animal body by peptone, by A. Gyergyai and P. Plosz.—On the conducting of electricity by flames, by F. Braun.—On the fauna of the Caspian Sea, by O. Grimm.—On the action of lime upon the germinating process of *Phaseolus multiflorus*, by J. Böhm.—The solubility of sodic nitrate and its hydrate, by A. Ditte.—The electric conduction resistance of air, by A. Oberbeck.—Influence of chlorine upon the nutrition of plants, by W. Knop.—On some experiments with disinfectants, by Herr Erismann.—Distinction between chemical and physiological ferments, by A. Müntz.—On the time of the disappearance of the ancient Fauna from the Island of Rodriguez, by A. Milne-Edwards.—Application of the tuning-fork to electric telegraphs, by P. La Cour.—On the climate at the Lower Jenissei, by W. Köppen.—Temperatures and specific gravity of the water of the German Ocean, by H. A. Meyer.—On the diffusion of moist towards dry air, by L. Dufour.—On the condensation of water in the soil, by A. Mayer.—What influences determine the sex of the hemp plants? by Fr. Haberlandt.

Transactions of the Academy of Science of St. Louis (*U.S.*), vol. iii. No. 2.—This part contains the following papers:—By Dr. C. V. Riley: "Hackberry Butterflies, Description of the early stages of *Apatura lycaon*, Fabr., and *Apatura herse*, Fabr., with remarks on their Synonymy;" "On the Oviposition of the Yucca Moth;" "Description of two new Subterranean Mites;" "Descriptions and Natural History of two Insects which brave the dangers of *Sarracenia variolaris;*" "Description of two new Moths." "Notes on the genus Yucca," by G. Engelmann; "On the Well at the Insane Asylum, St. Louis County," an account of a geological section, by G. C. Broadhead, who also contributes a paper "On the occurrence of bitumen in Missouri;" "Results of Investigations of Indian Mounds," by J. R. Gage; "Catalogue of Earthquakes in 1872-3," by R. Hayes; "On the Forms and Origin of the Lead and Zinc Deposits of S.W.

Missouri," by Dr. A. Schmidt; "On the *Terebratula mormonii*," by Jules Marcou; "On Climatic Changes in Illinois—its Causes," by A. Sawyer.

Annali di Chimica applicata alla Medicina, July.—The more important papers in this part are:—On some preparations from *Eucalyptus globulus* and *E. amygdalinus*, by G. Righini.—On soluble phosphate of lime, or hydrochloro-phosphate of lime, by G. Tarantino.—On a glycerine solution of salicylic acid, by Prof. S. Zinno.—On the hydrate of croton-chloral, by Dr. Weill.—On the aqueous solution of nitrous oxide, by Prof. Ritter.—On veratrine, by Lepage.—On the ozonisation of the air in unhealthy rooms, by Dr. Leuder.—On a green colour free from poison, by Prof. Casali.—On the function of wine in nutrition, by Bouchardat.—On diphtheria, by Dr. G. Tamborlini.—On a remedy against hydrophobia, by Jitzki.—On the reactions of cod-liver oil, by Buchheim.—On mineral waters in their relation to chronic diseases, by Durand Fardel.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, June 10.—On some mechanical effects of the electric spark, by E. Mach.—On the different solubility of different planes of the same crystal, and the connection of this phenomenon with some general principles of science, by Prof. Pfaundler.—On the boiling points of chloride of calcium solutions of different concentration, by the same.—On the latent melting heat of sulphuric bihydrate, by the same.—On the Pyrrhulina species of the Amazon River, and on a new Bryconops species, by Dr. F. Steindachner.—On the pretended dependence of the wave-lengths from the intensity of light, by Prof. F. Lippich.—Determination of the orbit of planet (100) Hecate, by Dr. J. E. Stark.—On the theory of the functions of three variables, by Prof. M. Allé.—On a new remedy against Phylloxera (ethylsulphocarbonate of potash), by Dr. Ph. Zoeller and Dr. E. A. Grete.—Dr. L. Löwy recommends salicylic acid for the same purpose.—Further researches on the molecular theory, by Dr. A. Handl.—On the determination of the mechanical equivalent of heat, by J. Puluj.

June 17.—Ichthyological researches, by Dr. Steindachner.—On some determined integrals, by Prof. L. Gegenbaur.—On the earthquake observed on June 12 in the vicinity of Vienna, by Prof. E. Suess.—On the conducting of heat by gases, by Prof. Stefan.—Meteorological observations made at Hohe Warte, near Vienna.

June 24.—On the determination of nitrogen in albuminates, by Dr. L. Liebermann.—On the quantities of nitrogen and albumen present in human and in cows' milk, by the same.—On the origin of the acacia gum, by Dr. J. Möller.—On alluvial territories, by Dr. A. Boué.—On a new method to use Böttger's sugar test, by Prof. Brücke.—On the action of chlorine upon solutions of sodic citraconate and sodic mesaconate, by Th. Morawski.—On the tannic acids of the oak, by Dr. J. Oser.—On the manner in which guano is formed, by A. Habel.

July 8.—On a new form of Fresnel-Arago's interferenee experiments with polarised light, by E. Mach and W. Rosicky.—On acoustic attraction and repulsion, by Dr. V. Dvorak.—On the elastic after-effects from torsion of steel wires, by Dr. J. Finger.—Some experiments on the magnetic effects of rotating conductors, by Dr. J. Odstrcil.—On the conversion of acids of the series $C_nH_{2n-2}O_2$ into such of the series $C_nH_{2n}O_2$, by Dr. G. Goldschmidt.—Theoretical kinematics, by F. Reuleaux.—On the influence of pressure and draught on the thermal coefficients of the expansion of bodies, and on the relative behaviour of water and caoutchouc, by C. Puschl.—On gentisine, by Herr Hlasiwetz and Dr. Habermann.—On glutaminic acid, by Dr. Habermann.—On the structure of the spinal ganglia, by Herr Holl.—On the Adriatic Annelida, by Dr. E. von Marenzeller.—Researches on artificial misformations in hens' eggs, by Dr. Szymkievicz.

PARIS

Academy of Sciences, Aug. 16.—M. Frémy in the chair.—The following papers were read:—Meridian observations of the minor planets, made at Greenwich Observatory (transmitted by the Astronomer Royal) and at Paris Observatory during the second trimester of the year 1875, communicated by M. Leverrier; the planets observed were Nos. 7, 25, 8, 82, 93, 53, 54, 108, 55, 23, 110, 72, 62, 68, 74, 128, 113, 26, 45, 29, 88, and 64.—Remarks by M. Leverrier on the lately discovered planets 144 and 145.—On the structure of the ovum and of the seed of Cycadeæ, as compared with that of different fossil grains of coal deposits, by M. Ad. Brogniart.—Some remarks by M. Chevreul on a historical note relating to J. B. van Helmont, *àpropos* of the definition and of the theory of a flame by M. Melsens.—Ninth note on the electric conductibility of bodies which are only moderate conductors, and on the electric polarisation of minerals, by Th. du Moncel.—A note by M. F. Tisserand, on the observations of shooting stars on Aug. 9th, 10th, and 11th last.—On the reducing action of hydriodic acid at low temperatures upon ethers proper and on mixed ethers, by R. D. Silva.—Synthetical researches on the uric group, by M. E. Grimaux (second paper).—A note by M. Cornu, on the presence of Phylloxera galls, spontaneously developed on European vines.—M. Vinot then presented an instrument to the Academy, which he calls *sideroscope* and, which enables any person, however ignorant of astronomy, to find easily all constellations and the principal stars.—Note on a new method of giving proper signals at sea, by M. Trève.—On the action of copper and its derivatives on the animal organism, by MM. Ducom and Burg.—On an acid obtained from wine, which turns the plane of polarisation to the right, by M. Maumené.—Analysis of the gases given off by the soil on the island of St. Paul, by Ch. Velain.—On Blaen's globes, and on a discovery made by the same in 1600, of a variable star in the constellation of Cygnus, by M. Baudet.—Fourth note by M. J. M. Gaugain on the process of magnetisation.—On some new singing flames, by M. C. Decharme.—Researches on tempered glass, by MM. V. de Luynes and Ch. Feil.—On some double metallic sulphocarbonates, by M. A. Mermet.—On a proper reaction by which to recognise sulphocarbonates in solution, by the same.—On the active part in the seeds of pumpkins as employed as a remedy against tape-worms, by M. E. Heckel.—On the post-tertiary fauna of the caves of Baoussé Roussé in Italy, commonly called grottoes of Mentone, by M. E. Rivière.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—A Yachting Cruise in the South Seas: C. F. Wood (H. S. King and Co.)—Transactions of the Watford Natural History Society, Vol. i. Part 1—Rotomahana, and the Boiling Springs of New Zealand, by D. L. Mundy and Ferd. von Hochstetter (Low and Marston).—Journal of the Anthropological Institute, Vol. iv. Part 2; Vol. v. Part 1.—Snicland, or Iceland; its Jokulls and Fjalls: W. L. Watts (Longmans).—Protection of Life and Property from Lightning: W. McGregor (Bedford, Robinson).—Game Preserves and Bird Preservers: G. F. Morant (Longmans).—Geology: James Geikie (Chambers)—Magnetism and Electricity: John Cook (Chambers).—Chemistry: A. Crum-Brown (Chambers)—Astronomy: A. Findlater. (Chambers).—On the Relation between Diabetes and Food: Dr. Donkin (Smith, Elder and Co.)—Impressions of Madeira: Wm. Longman (Longmans)—Light as a Motive Power: Lieut. R. H. Armet, Vol. i. (Trubner).—Rambles in Search of Shells: J. E. Harting (Van Voorst).—Syllabus of Plane Geometry (Macmillan and Co.)—Instructions in the Use of Meteorological Instruments: Robt. H. Scott, M.A., F.R.S. (Official).—Quarterly Weather Report of the Meteorological Office, Part 4, 1873 (Official).—Second Report on the Sanitary Condition of Oxfordshire: G. W. Child (Longmans).

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THURSDAY, SEPTEMBER 2, 1875

*THE SCIENCE COMMISSION REPORT ON THE ADVANCEMENT OF SCIENCE**

WE now proceed to indicate the tenor of the evidence received by the Royal Commission on the last two heads under which they have classified that part of their inquiry which relates to the Advancement of Science.

III.—*The Assistance which it is desirable the State should give towards that object* [the promotion of Scientific Research.]

On this head the evidence is enormously voluminous, and it may be said to be practically unanimous in demanding a very great increase to the aid now given towards original scientific investigation and observation. In order to afford some idea of the general tendency of this mass of testimony, we cannot do better than summarise the extracts appended in their Eighth and Final Report to the recommendations of the Commission.

As to the general question, which must precede all others, whether the State should aid science, the Commission refers first, with great propriety, to the opinions of eminent statesmen on what is as much a problem of statescraft as a question of science.

The evidence of Lord Salisbury is emphatic :—

> "Do you hold that the State may legitimately interfere in giving aid to the advancement of science?—I certainly do. It is a very orthodox doctrine to hold, and one which could be supported if necessary by quotations out of Adam Smith, the essence of the doctrine being, that the State is perfectly justified in stimulating that kind of industry which will not find its reward from the preference of individuals, but which is useful to the community at large."
>
> "The State has already, to a considerable extent, recognised, has it not, that duty; and there are a considerable number of scientific institutions supported more or less by the State?—No doubt the State, in the money that it gives, and has given in past times, to the best Universities, has recognised that duty."
>
> "There are the Observatory at Greenwich, the British Museum, and Kew Gardens; you would consider those as instances in which the State aids the promotion of science?—They would be all instances in point; and I do not apprehend that as to the abstract doctrine itself there has ever been any serious contest." . . .

Lord Derby's evidence in favour of State aid to science is all the more weighty from the limitations by which he guards it :—

> "I think there has been a very general consent amongst a large number of men of science who have been examined before this Commission that in the present state of science there are many branches as to which there is no probability of their being advanced to the degree to which they are capable of being advanced by private effort, and without the assistance of State funds in some shape; what is your lordship's opinion upon that subject?—I am, as a general rule, very strongly in favour of private effort, and very decidedly against the application of State funds to any purpose that can be accomplished without them; but I think that if there is any exception to that which I venture to call a sound and wholesome rule, it is in the case of scientific research, because the results are not immediate, they are not popular in their character, and they bring absolutely no pecuniary advantage to the person engaged in working them out. A great mathematical or a great astronomical discovery is a benefit to the whole community, and in a certain sense to mankind in general; but it is productive of absolutely no benefit, in a pecuniary point of view, to the person who has given his labour to it."

Sir Stafford Northcote thus states his opinion on the point :—

> ". . . The State should do what it can both to promote scientific education and also to assist in the prosecution of scientific experiments and inquiries when they can be best prosecuted by the aid of the State."

It is a matter of congratulation that these opinions, though expressed when out of office, are held, and will doubtless be maintained, by three of the foremost members of Mr. Disraeli's Cabinet. Nor can we forget that the Premier himself some time ago forcibly descanted on the extreme value of sanitary science, or that the Home Secretary, who has laboured so zealously in many departments of social reform, reminded the House of Commons, during the late session, that the proper method of paving and cleansing our wretched London streets really involved difficult scientific problems, at present neglected, and with nobody to undertake their solution.

The Commissioners observe that "on the proposition that it is the duty of the State to encourage original research they might multiply their extracts from the evidence indefinitely," and they refer to the scientific testimony of Dr. Frankland, Sir W. Thomson, Dr. Joule, Mr. Gore, Dr. Carpenter, Prof. A. W. Williamson, Mr. Reed, Sir E. Sabine, Dr. Siemens, Dr. Sclater, Mr. Farrer, Admiral Richards, and numerous others, to show that the aid of Government to scientific research has been beneficial, so far as it has gone, but that it has been insufficient and should be increased; and as representing the opinions of public servants occupying high official positions in Government departments, they refer to the evidence of Admiral Richards, late Hydrographer of the Admiralty, and to that of Mr. Farrer, Secretary to the Board of Trade.

The broad general principle that the State should aid original research, and that it at present does so insufficiently, being established, the next question is in what direction is additional aid required? The evidence on this question is classified by the Commissioners under the heads Laboratories, Physical Observatories, Meteorology, Tidal Observations, the Government Grant administered by the Royal Society, and Payment of Scientific Workers.

Evidence relating to the Establishment of Laboratories.—Amongst the witnesses who are in favour of the erection of new laboratories for research is Colonel Strange, whose view of the national requirements in these respects is thus given :—

> "Will you be so good as to enumerate the institutions which you think should be under the State?—(1) an observatory for physics of astronomy; (2) an observatory for terrestrial physics, namely, meteorology, magnetism, &c.; (3) a physical laboratory; (4) an extension of the Standards Office; (5) a metallurgical laboratory; (6) a chemical laboratory; (7) an extension of collections of natural history, and an able staff of naturalists; (8) a physiological laboratory; (9) a museum of machines, scientific instruments, &c. I believe that under one or

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* Continued from p. 285.

other of these and existing institutions every requisite investigation will range itself. I have not stopped to inquire whether one or another is more or less important. My aim in the spirit of my postulate No. 2[*] has been *completeness*. It may be necessary for a manufacturer to prosecute only such particular investigations as promise direct and speedy profit. A great nation must not act in that commercial spirit. All the operations of nature are so intimately interwoven, that it is impossible to say beforehand that a given line of research, apparently unproductive, may not throw light in unsuspected directions, and so lead to untold and undreamt-of treasures." . . .

Sir W. Thomson's evidence is as follows :—

"Are you of opinion that any national institutions supported by the Government are required for the advancement of science ?—I think that there ought to be institutions for pure research supported by the Government, and not connected with the Universities. The only suitable place at present for such institutions would be London, or the neighbourhood of London ; in that situation, I believe, very great things could be done by institutions for pure research, at which work of a very great immediate money value would be produced at an extremely moderate cost, and I believe that discoveries redounding to the honour and credit and pleasure of this country would infallibly be made."

"Are you able to give any idea as to how many such institutions would be required?—There should be five. One at present exists, namely, the Royal Observatory at Greenwich. Another in my opinion is very much wanted, an observatory for astronomical physics, then again a physical laboratory, and a laboratory for chemical research, and a physiological laboratory are necessary." . . .

"Would such a physical laboratory differ in any essential respects from a physical laboratory attached to an University?—Yes ; it would be adapted solely for research, with no provision for pupils except what may be called apprentices, or pupils for research ; no provision for teaching the mere elements of manipulation, but provision for researches directly adapted to increase knowledge, and for making pattern researches for the sake of training research pupils who had already gained experience and proved ability in institutions of instruction."

"Would you leave the researches to be carried on at such a laboratory mainly to the discretion of the person who had charge of it, or would you place it in any degree under the control of the council of which you have been speaking ?—I would leave it to the discretion of the person who has charge of it." . . .

"And that the Government should also be able to command investigation on the advice of the council ?—Yes."

"Of course the director would report ?—Yes, the director would report on everything, both researches undertaken at his own instigation, and investigations undertaken for the council or for the Government."

"And your view of what should be done in the chemical and physiological laboratories would, I presume, be something of the same nature ?—Yes, something of the same kind, *mutatis mutandis*."

"With respect to the apparatus, and the annual supply of apparatus, it is probable, is it not, that the physical laboratories would be the most costly ?—Yes, the most costly in apparatus."

"Some very fine instruments of a costly kind are now required in physiological inquiries, and large pieces of apparatus are sometimes employed, such as the respiration apparatus at Munich, which was put up on the recommendation of Prof. Pettenkofer ?—Yes, it would be in my opinion necessary not to limit to a fixed endowment the expenditure of any one of those institutions, but to let it be determined (if I may use the expression once more) by natural selection ; applications for money to be made to the council to be duly weighed, and the council to apply to the Treasury. That would be much more economical than giving a fixed sum which, being to be spent, might be spent without due regard to economy, or which, on the other hand, might prove to be insufficient for valuable researches, causing the institution thereby to be crippled and to lose efficiency."

"You would not think it indispensable, would you, that such institutions, if the Government thought fit to establish them, should be in the heart of London, or in any very central situation ?—No ; it would be much better that they should be in the country in positions conveniently accessible to London." . . .

"You would not institute any regular provision for teaching in those laboratories ?—No."

"But you would allow young men or students who wished to carry out original research to avail themselves of them under the direction of the persons who were in charge of them ?—Yes, under the direction, and to some degree under the instruction of the persons in charge ; but the instruction should be limited to methods for advancing science. The director of such an institution must not be occupied with lecturing in any other institution, or with lecturing at all. He ought indeed to be prohibited from lecturing, except one or two occasional lectures in the course of a year."

"You think that the object for which you recommend the establishment of those laboratories could not be accomplished by any other means—not by investigations carried on in other laboratories in the country ?—Certainly not by any other means."

Dr. Frankland thus refers to the double function which such laboratories might perform, and states his view in reference to their management :—

"Can you make any suggestions as to stimulating original research in this country ?— . . . . We have in this country a considerable body of investigators who are not engaged in teaching at all, and I think that this is a peculiarly hopeful feature of our case. It shows that the English have not only a taste for research, but that they have a natural talent for it. We have numerous men like Mr. Gassiot, Sir W. Grove, Dr. De la Rue, Mr. Spottiswoode, Mr. Huggins, Mr. Duppa, Mr. Buckton, Mr. Joule, Mr. Lockyer, Mr. Perkin, Mr. Schunck, Col. Yorke, and others whom I could name, who are not in any way engaged in teaching, and never have been, but who have made important original researches, and have spent a good deal of their time in the working out of new discoveries. Now that method of stimulating research which I have mentioned in my former examination would not of course apply to them. Men of this class are really peculiar to England, for I have never known any such instance in Germany or in France, of men altogether disconnected with teaching taking up research in the way it is done in England. I think that for such men the establishment of national institutions such as those which are recommended by Col. Strange would be peculiarly useful. In fact, I have heard several of these gentlemen express strong opinions as to the great advantage it would be to them if they could go to some institution of that kind to conduct research, where expensive instruments, which are often required for their experiments, were provided for a number of such investigators, and where appropriate rooms for carrying on these researches could be had. It is exceedingly difficult to carry on chemical research in one's own house, because of the want of proper contrivances for dealing with corrosive gases and vapours; and hence appropriate buildings ought to be provided for carrying on such investigations. I think, therefore, that it would afford a great stimulus to research of this kind if such institutions were provided, and furnished with such instruments as would be generally useful in research, leaving the more special instruments and materials adapted to the particular researches themselves, to be provided by each operator. . . . I have reason to believe that no inconsiderable number of men, more especially of those educated in some of the science schools, would undertake researches if such facilities were afforded them."

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[*] Col. Strange opened his evidence before the Royal Commission in the following terms :—

"I can hardly do better than by stating the four postulates on which I base all my recommendations : it seems to me indispensable that I should state the basis upon which I am about to speak. Those postulates are as follows :—(1) That science is essential to the advancement of civilisation, the development of national wealth, and the maintenance of national power. (2) That all science should be cultivated, even branches of science which do not appear to promise immediate direct advantage. (3) That the State or Government, acting as trustees of the people, should provide for the cultivation of those departments of science which, by reason of costliness, either in time or money, or of remoteness of probable profit, are beyond the reach of private individuals ; in order that the community may not suffer from the effect of insufficiency of isolated effort. (4) That to whatever extent science may be advanced by State agency, that agency should be systematically constituted and directed."

"Would you consider the chief use of such institutions as laboratories to be to enable private inquirers to carry on their researches, or would you propose that any investigations should be carried on there on behalf of the State?—I think that both things might be provided for. The State requires many important investigations to be carried on. . . . . That might well form one part of the objects of such a building, but I should think that so far as abstract research, of which we are more especially speaking now, is concerned, the other portion of those objects, namely, the encouragement of original investigation in the case of amateurs would be more important, because the investigations made for the Government are essentially practical investigations; they are not usually of that character which lead to discoveries or to the advancement of science."

"Would you place those laboratories under a permanent official?—They must of necessity be under the direct and constant superintendence of some one thoroughly conversant with the operations going on in them; and, so far as the conducting of the separate original researches is concerned, I think that it would be very desirable that the admission into such institutions should be granted through some such body as the Research Fund Committee, for instance, of the Council of the Royal Society, or some body of that kind, who would make intelligent and impartial inquiry into the qualifications of the men applying for accommodation."

"You would not throw upon the director the sole responsibility of deciding who should be admitted and who should not?—I think that would not be desirable." . . .

"And do you think it would be requisite that those institutions should be on a large scale?—I think that they ought to be on a fairly large scale even to begin with, because it is always a costly process to rebuild such institutions; and I am inclined to think that they would be rapidly filled. A tolerably large institution of that kind would probably in a very few years be filled with workers." . . .

"You would not recommend, in the first instance, at least, more than the establishment of one for each department of science?—I think not more than that."

"And should it be in London?—Yes, I suppose they must be commenced here, but eventually it would be desirable that the important centres in the provinces should also be furnished with such places."

"Col. Strange recommended the establishment of four laboratories; should you be disposed to agree with him in that view?—Yes, I think that those would be necessary; perhaps the least essential of them would be the metallurgical one, but certainly the others would be quite essential."

Mr. Warren De la Rue, whose opinion on this subject, as that of one of the most eminent private scientific workers on a large scale, must have peculiar weight, expresses himself as follows:—

"Are you of opinion that any new institutions in the way of laboratories should be established by the State?—I hold it to be so important that chemistry should be extensively cultivated in England, that I would strongly advocate that there should be a State laboratory. That State laboratory should undertake all the chemical work which the Government might require, but at the same time, according to the views which I hold, it ought to be such an establishment as could afford facilities to men who have completed their scientific education, and who might be desirous of continuing original investigations, in which space for working and instruments should be afforded them; and, moreover, if men were not in a position of fortune to continue their researches, in some cases materials and even money might be granted to them on the recommendation of the council. I may state that of my own knowledge I know that chemical science at present is not progressing in England in a satisfactory manner, that we do not make so many original researches as our continental neighbours, particularly the Germans, do. In Germany very great patronage is given to science, magnificent laboratories have been built, and the students, who, after they are sufficiently advanced, are encouraged to make original investigations, contribute at present most largely to scientific chemistry."

"Do you think that the establishment of those Government laboratories would be likely to give rise to complaints from any existing institutions?—I think not, if those Government establishments were not educational establishments. . . . What I contemplate is merely that facilities should be given to men who have already been educated, and not to interfere at all with the functions of educational establishments."

"Do you think that any other laboratories would be needed?—I attach the greatest importance to a chemical laboratory, because I believe that chemistry is destined to play a very important part in the advancement of the arts in all civilised countries, but there also ought to be a physical laboratory very much on the same footing as the chemical laboratory, and in which facilities should be afforded for conducting physical investigations."

"You would give admission to those laboratories on the same principle as to the chemical laboratories?—Yes, to men who could show that they were qualified to make a beneficial use of them."

"You think that any investigations required by the State should also be conducted there?—Yes, they should be conducted in either the chemical or physical laboratory, according to the nature of the investigations. For example, there were a great number of investigations carried on at Woolwich relating to the strength of different alloys whose chemical composition was determined by analysis. Such investigations would be very well conducted in the chemical laboratories."

"Would you transfer the work now done at Woolwich to such a laboratory?—Part of the work, but I would except such special work as could be better done at each of the Government establishments. Special investigations would fall within the duties of the central government laboratory. The testing of the purity of the products to be used in the department and routine work would be better conducted in those establishments."

"With respect to the other purpose of the laboratory, do you think that there would be a sufficient number of independent inquirers to occupy an establishment like that?—I think that there would be a great number of men who would be very glad to avail themselves of such opportunities as a laboratory of that kind would afford, and their doing so would not add materially to the cost of the establishment."

Mr. Gore, a distinguished practical chemist, also recommends the establishment of laboratories, his evidence being essentially of the same purport as that quoted above.

The great bulk of the evidence, in fact, on this part of the question is to the same effect; and it has not been neutralised, in the judgment of the Commissioners, by other views expressed by a small number of distinguished witnesses.

Amongst the latter Dr. A. W. Williamson thinks that the development of schools would be preferable to the establishment of laboratories. His views however do not seem to be fully matured; the following extract from his evidence showing that though more in favour than perhaps anyone else of equal authority, of combining school instruction with original research, he still perceives that some independent provision for the latter might be desirable. He says:—

> "At the same time it is quite possible that, in exceptional cases, research might with advantage be carried on in separate places; but I should always view with regret, as a waste of resources, the separation of that higher work of research from the more humble work of teaching, which naturally belongs to it. They help one another, and I think that each would lose from being separated from the other; still, in some cases, it might possibly be advisable."

Dr. Siemens, on the other hand, apprehends that the establishment of Government laboratories, which, amongst other functions, should be accessible to private workers, might cause disappointment to some who might not be able to gain access to them, and that there might be favouritism and want of discrimination in the dispensing of the privileges in question.

Dr. Burdon Sanderson would rather see increased facilities given to the great schools of medicine for the prosecution of physiological research, than laboratories of an independent character established. He questions whether we have at present a sufficient number of trained workers to use establishments of the latter kind; whilst Lord Salisbury is doubtful whether by any moderate expenditure of funds we could provide an expensive class of scientific instruments of all kinds for all the persons who might be inclined to use them.

The Commissioners, after fairly balancing the views laid before them, sum up this question in their final conclusions, as follows:—

"More complete means are urgently required for scientific investigations in connection with certain Government departments; and physical as well as other laboratories and apparatus for such investigations ought to be provided."

(*To be continued.*)

IRBY'S BIRDS OF GIBRALTAR

The Ornithology of the Straits of Gibraltar. By Lieut.-Col. L. Howard L. Irby, F.Z.S., &c. (London: R. H. Porter, 6, Tenterden Street; Dulau and Co., Soho Square, 1875.)

HERCULES, as in our schooldays we used to be told, once took the trouble of cleaving asunder the isthmus which in his time, whenever that was, joined Europe and Africa. Colonel Irby has been at the pains of reuniting the two continents, not indeed actually, but for the purposes of his work; and has thus undone, so far as ornithology is concerned, the labour of the demigod. Though we certainly have no fault to find with the exploit which gave the waters of the Atlantic access to the Mediterranean basin, and fully admit the advantage which has thereby accrued to most European nations, and to our own in particular, it must be confessed that we deem more highly the feat of our modern hero than the prowess of him of antiquity.

It is now some years since all authorities have recognised the fact that, if socially Africa begins, as the satirical statesman said, at the Pyrenees, Europe does not biologically end at the Strait of Gibraltar; and the readers of NATURE do not need reminding that between the animal and vegetable products of either side of that narrow channel there is little essential difference. Thus the southern part of Andalucia and the northern part of Morocco form a very homogeneous district to come under the survey of an observant ornithologist perched upon the rocky heights of "Old Gib." Such an observant ornithologist Col. Irby has proved himself to be, as might indeed have been expected of him, when we remember that he was one of the few officers of the now ancient Crimean time who was sufficiently undisturbed by war's alarms to follow his pursuits over the steppes of the Tauric Chersonese, and again, when called not long after to India, in days yet pre-Jerdonian, did not intermit his occupations in Oudh and Kumaon for all that rebellion, if not something more, was still rife in those districts.

We have seldom had the pleasure of reviewing a more engaging and more unpretending book than that which is now before us. It is by one who shows himself in almost every page to be a thorough field-naturalist, and a field-naturalist of the best kind. Cherishing with pardonable pride, as a man should do, his own observations, he can yet believe that those of others may likewise have some merit, and thus he gives us an admirable account of the place of his choice, though, as he modestly remarks, "there is ample room for anyone with energy to work out a great deal more information on the birds of the Straits." Nearly all that he has to say about those of the Spanish side is from his own personal knowledge, acquired during a more or less prolonged stay at "the Rock," between February 1868 and May 1872, and again from February to May 1874, but including in this time only one summer. "For the first three years of my residence at Gibraltar," he says, "I was quartered with my regiment, the remaining time being passed there chiefly with a view to ornithological pursuits, from time to time making excursions, generally of about a fortnight's duration, to some part or other within the districts above mentioned, but chiefly confining my attentions to the country within a day's journey of Gibraltar." The observations on the Moorish birds are in great measure culled from the manuscript of the late François Favier, a French collector well-known to many ornithologists in England, who died in 1867 after a residence of more than thirty years at Tangier. This manuscript our author secured at a high price,* to find indeed, "amidst a mass of bad grammar, bad spelling, and worse writing, which cost many hours to decipher, that it did not contain so much information as I had reason to anticipate, a good deal of the matter having been copied from other authors;" and, we may add, not copied with much discrimination.

The remaining materials of which the Colonel has availed himself (would that he had discovered the lost *Fauna Calpensis* of John White !) are the various papers on Spanish Ornithology, by Lord Lilford and Mr. Howard Saunders, published in the *Ibis*, and the late Mr. C. F. Tyrwhitt Drake's notes on the birds of Tangier and Eastern Morocco, which appeared in the same journal. The list of Tangerine birds by Herr Carstensen (*Naumannia*, 1852, i. pp. 76-79) gave but little help ; but our author does not seem to have been aware of the late Mr. G. W. H. Drummond Hay's observations (*Proc. Zool. Soc.* 1840, pp. 133-135), which, though brief, appear to be at least trustworthy.

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* This manuscript, or possibly an older one of which it is a corrected copy, was seen at Tangier in 1844 by Wolley. Colonel Irby has lately presented it to the Zoological Museum of the University of Cambridge.

Colonel Irby catalogues 335 species as unquestionably occurring within his limits, besides some twenty-five more which may be reasonably looked for, though he himself has not fallen in with them ; while many others are doubtless to be found as stragglers, for "so local are birds in Southern Spain, that perhaps some may be resident and overlooked in consequence of the exact locality they frequent having been unvisited." His remarks on all these are exceedingly discriminative and to the point, furnishing a supply of information for which ornithologists will be duly grateful, but they are mostly of too special a kind to give extracts from them here. We prefer quoting what he has to say on Migration, as being a subject in which more of our readers will take interest :—

> "Without doubt caused by the absence or abundance of food, which in turn is caused by difference of temperature, the passage of birds in these parts begins with most species almost to a day in spring, usually lasting for about three weeks, though some, as the Hoopoe and the Swallows, are more irregular in their first appearance ; and with these the migration lasts throughout a longer period.
>
> "Few (indeed hardly any birds) do not migrate or shift their ground to some extent. I can name very few which do not appear to move, viz., Griffon-Vulture, Imperial Eagle, Eagle-Owl, Blue Thrush, all the Woodpeckers, Treecreeper, Black-headed Warbler, Dartford Warbler, Crested Lark, Chough, Raven, Magpie, Red-legged and Barbary Partridges, and the Andalucian Quail. Generally speaking, it seems to me that in the vernal migration the males are the first to arrive, as with the Wheatears, Nightingales, Night-herons, Bee-eaters ; but this is a theory which requires more confirmation. Some species, as the *Neophron* and most of the *Raptores*, pass in pairs.
>
> "Most of the land-birds pass by day, usually crossing the Straits in the morning. The waders are, as a rule, not seen on passage ; so it may be concluded they pass by night, although I have occasionally observed Peewits, Golden Plover, Terns, and Gulls passing by day.
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> "The autumnal or return migration is less conspicuous than the vernal : and whether the passage is performed by night, or whether the birds return by some other route, or whether they pass straight on, not lingering by the way as in spring, is an open question ; but during the autumn months passed by me at Gibraltar, I failed to notice the passage as in spring, though more than once during the month of August, which I spent at Gibraltar, myself and others distinctly heard Bee-eaters passing south at night, and so conclude other birds may do the same.
>
> ". . . Both the vernal and autumnal migrations are generally executed during an easterly wind, or Levanter ; at one time I thought that this was essential to the passage, but it appears not to be the case, as, whether it be an east or west wind, if it be the time for migration, birds will pass, though they linger longer on the African coast before starting if the wind be westerly ; and all the very large flights of *Raptores* (Kites, Neophrons, Honey-Buzzards, &c.) which I have seen passed with a Levanter. After observing the passage for five springs, I am unable to come to any decided opinion, the truth being that, as an east wind is the prevalent one, the idea has been started that migration always takes place during that wind. Nevertheless, it is an undoubted fact that during the autumnal or southern migration of the Quail in September they collect in vast numbers on the European side if there be a west wind, and seem not to be able to pass until it changes to the east ; this is so much the case that, if the wind keeps in that quarter during the migration, none are hardly to be seen.
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> "On some occasions the passage of the larger birds of prey is a most wonderful sight ; but of all the remarkable flights of any single species, that of the Common Crane has been the most noteworthy that has come under my own observation.
>
> "On the Andalucian side, the number of birds seen even by the ordinary traveller appears strikingly large, this being, no doubt, in a great measure caused by the quantity which are, for ten months at least out of the year, more or less on migration ; that is to say, with the exception of June and July, there is no month in which the passage of birds is not noticeable, June being the only one in which there may be said to be absolutely no migration, as, during the month of July, Cuckoos and some Bee-eaters return to the south" (pp. 13-15).

For want of space we must pass over the spirited descriptions which the Colonel gives of the various localities within his limits, and his experience of several shooting excursions, the relation of which is wisely subordinated to the main object of the book. We can fully enter into his feelings when he was for two hours the unobserved observer of a vast assemblage (at the lowest computation, he says, between three and four thousand) of wild geese, for we ourselves remember watching just such a host, and under much the same circumstances, years ago on the banks of a Lapland river ; but we cannot here introduce his account. Our author has added to the value of his book by giving a list of the Mammals of Southern Spain, *forty* in number without counting the Barbary Ape, whose presence on "the Rock" is the origin of so many theories facetious as well as scientific ; and the volume concludes with a convenient summary of the Birds, besides a very good index. As reviewers we are of course entitled to our "growl," and this shall be that the two neat maps which illustrate the book are not drawn to the same scale, and while that of Northern Morocco, for which we are especially thankful, takes in a great deal more than Colonel Irby's district, that of Southern Spain leaves out at least as much. With this we bid him farewell.

HOFMANN'S REPORT ON THE PROGRESS OF CHEMICAL INDUSTRY

Bericht über die Entwicklung der Chemischen Industrie während des letzten Jahrzehends; im Verein mit Freunden und Fachgenossen erstattet von Dr. A. W. Hofmann. Autorisirter Abdruck aus dem Amtlichen Bericht über die Wiener Weltausstellung im Jahre 1873. (*Report on the Development of Chemical Industry during the last Ten Years;* in conjunction with friends and fellow-workers. Composed by A. W. Hofmann. Authorised reprint of the official report on the Vienna Exhibition of 1873. Vol. iii. Part I.) (Braunschweig: Fr. Vieweg und Sohn, 1875.)

THE Imperial Commission of Germany for the Vienna Exhibition of 1873 have put the report on the third group, "Chemical Industry," into the hands of Dr.

Hofmann, of Berlin. Considering the well-deserved international position of Dr. Hofmann, his personal influence on the development of applied chemistry as well as of pure science, and the excellent official English report he wrote on the Chemical group of the London Exhibition of 1862, no better choice could possibly have been made. Wishing to give a more comprehensive work even than that of 1862, and to do so within reasonable time, Dr. Hofmann had recourse to a subdivision of labour, and a great number of practical and theoretical chemists of different nations have contributed articles for this work. Some of these contributors, such as Professors Frankland of London, and Wurtz of Paris, occupy eminent scientific positions; others are eminently fitted for the subjects they have treated by their practical pursuits. The report is intended to come out in three parts, containing the industrial applications of metalloids, of metals, and of organic compounds respectively. The first part, which has appeared, contains the following succession of papers:—"The Elements of Water," containing oxygen, hydrogen, and also ozone and peroxide of hydrogen, by Dr. A. Oppenheim; "On Drinking-water," by Dr. Edw. Frankland; "On the artificial production of Cold and Ice," by Dr. H. Meidinger; "On Chlorine, Bromine, Iodine, and Fluorine," by Dr. E. Mylius; "On the Sulphur-industry of Sicily," by Dr. Angelo Barbaglia; "The Manufactory of Sulphuric Acid," by R. Hasenclever, director of the Rhenania Chemical Works at Stolberg; "Ammonia," by M. Seidel, manufacturer at Amsterdam; "Nitric Acid," by Dr Ad. Geyger; "Protoxide of Nitrogen," by Dr. O. Liebreich; "Phosphorus and its Applications," by Dr. A. v. Schrötter (the discoverer of amorphous phosphorus); "On Carbon and Graphite," by Dr. R. Biedermann; "On Sulphuret of Carbon," by Dr. O. Braun, manufacturer at Berlin; "Cyanides," by Dr. E. Meyer, director of the Koepenik Chemical Works; "Silicates," by Dr. R. Biedermann. This enumeration shows that the variety of subjects treated on in about 350 pages is too great to allow of a detailed review, and we can only say that many of these papers offer an unusual interest.

The leading idea has been to give first a short history of the manufactures in question, and then a succinct account of the latest improvements. The most prominent samples exhibited at Vienna and the prizes awarded by the jury are shortly mentioned. The book is designed by its editor to be more than a monument of the last International Exhibition, viz., a history of chemical industry in a very readable form, and a desirable addition to the existing manuals of pure and applied chemistry. He has taken great pains not only in gathering an effective staff of fellow-workers around him, but in distributing the work, adding supplementary information, and arranging the papers in a systematic form.

Very many of the communications which appear here in print are based upon letters elicited from the best known manufacturers of various countries. The second part of the Report is now about to leave the press, and the third part is expected to be printed during the coming winter. An English translation and an Italian one are being prepared at the same time.

A. Oppenheim

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

The Spectroscope and the Weather

We were visited here, on the 11th inst., by a very severe thunderstorm, beginning a little before noon and lasting for about an hour and a half. Anxious to confirm some observations made recently in the West Indies, in which I got from lightning a *continuous* spectrum, I took out my pocket spectroscope, and on looking through it was at once struck by the peculiarity of the spectrum. The band noticed by Prot. P. Smyth (vol. xii. pp. 231, 252) on the less refrangible side of D was very distinct, while the band (W.L.L. 5830–5680) on the more refrangible side of D was also very, though not nearly so dark, leaving the appearance of a bright yellow band over the part of the spectrum W.L.L. 5880–5830, as in the sunset spectrum, only much more marked. The A, B, and C lines were all visible; E and *b* were very sharp, *b* being easily separable into three lines; while there was also a dark band (W.L. 5040?) between *b* and F, but no lines visible *beyond* F. The most peculiar point, however, was the rapidity with which the spectrum varied, for, keeping the instrument pointed in one direction, each different cloud that passed differed in the intensity of the darkness of the band W.L.L. 5970–5900, which sometimes could be distinctly separated from D, while at other times it appeared quite continuous with it. The darkest bands were given by the lurid purple and pillared white-grey clouds. During all this time the heat had been intense, and the thunder was accompanied by light gusts of wind varying as much as 90° in direction, but about 1 o'clock rain began to fall and the abnormal bands to disappear. By 4 P.M. the band W.L.L. 5830–5680 was almost quite gone, and the band W.L.L. 5970-5900 had also become faint, appearing like a shadow cast by D, which was sharp and clear except in the light reflected from a few of the heaviest clouds. On the 12th the sky was still very much overcast and the spectrum again slightly abnormal, but not more so than I have noticed it in a thick "Scotch mist." To-day, with sky still completely overcast, the spectrum is quite normal.

The instrument used was one of Ladd's excellent small pocket spectroscopes. C. Michie Smith

F. C. Manse Keig, Aberdeenshire,
Aug. 13

Sea Elephants from Kerguelen's Land at Berlin

The expedition sent by the German Governwent to observe the Transit of Venus at Kerguelen's Land has brought home a noble series of specimens.

The most interesting of these are the skins and skeletons of male and female Sea Elephants (*Cystophora leonina = Morunga elephantina*, Gray), adult and young. The largest male is fortunately full grown, though not old, or of so large a size as some of the skulls preserved in other museums would apparently indicate. Still it is a noble specimen, and has been admirably prepared under the direction of Prof. Peters. The skeleton, when ready, will be mounted and placed by its side in the museum.

Though the existence of this wonderful Seal was made known more than a century ago by Pernetty, and subsequently described with more or less graphic detail and exactness by Anson, Cox, Péron, and other antarctic explorers, when it inhabited comparatively accessible localities, there was, so far as I know, no full-grown male specimen in any European museum until this one reached Berlin; and it is only a full-grown male, as is well known, which possesses the remarkable nasal appendage which suggested the name "Sea Elephant." A young male can hardly be distinguished from a female. Some writers have described the appendage as a sort of trunk—more than a foot long—indeed it is so figured in the plates to Péron's "Voyage aux Terres Australes;" but Anson, speaking of those he found at the island of Juan Fernandez, compared it to the wattles of a cock. The justice of this comparison is well shown in the Berlin specimen. The appendage is there seen to be a hoodlike dilatation of the nostrils, much wrinkled and puckered, and subdivided by transverse constrictions at intervals of about three inches. It was found impossible to extend it into anything like a trunk, though it was quite soft and flexible when it arrived, having been sent home in salt. In fact, it closely resembles the "hood" of the Bladder-nosed Seal (*Cystophora cristata*), but is smaller in proportion to the size of the animal, and different in shape. Péron, who described it as a trunk, was so good an observer, and generally so trustworthy, that I can hardly believe that he invented the resemblance; indeed he called the animal "Phoque à trompe" in consequence of its possession of it. Might not the individuals that he described, which inhabited Bass's Straits, have belonged to a different species? The upper lip is about two inches high, above which the crest, or hood, rises four inches more, and is prolonged backwards over quite half the head, in the integuments of which it is gradually absorbed. The animal measures fourteen feet six inches in length from tip of nose to tip of tail, and sixteen feet three-and-a-half inches to the extremity of the hind flippers, taking the measurements along the curve of the back. The total length along the ground is fourteen feet one inch. The girth is eleven feet, measured just behind the hands. The vast bulk of the fore-part of the body; the diminutive hands, armed with long nails; the short, widely spreading feet; the thick, clumsy neck, and the huge head crowned with its strange appendage, recall exactly the male animal depicted in the plate of "A Sea Lion and Lioness from Juan Fernandez" in Anson's voyage, over which it has been the fashion to make merry for the best part of a century; and vindicate the accuracy of that intrepid seaman. The skeleton was in process of maceration, with the exception of the head: this measured rather less than two feet in length. The sutures are all open, and the teeth unworn. It was impossible to examine the other bones with any accuracy, but the epiphyses appeared to be united. Besides the skin and skeleton of the full-grown male, there are the following:—

Young male, eight days old, skin stuffed, skeleton complete.
" older, skin without skeleton.
Female, full-grown, skin stuffed, skeleton complete.
" " skull and imperfect skeleton.
" " three skins.

The expedition has also brought home a male and female *Otaria* of singular beauty, quite new to science, for which Prof. Peters has proposed the name *Arctophoca gazella*, from the name of the vessel on board of which the voyage was made. There are also a skin and skeleton of the Leopard Seal (*Stenorhynchus leptonyx*), and many skeletons of Albatross, Penguin, Petrel, and Sheath-bill. Last, but not least, there is a skeleton of a *Delphinus* from the African coast, which will probably turn out to be either new, or one of those that have hitherto been known from skulls alone brought home by sailors.

While one cannot give too much praise to the skill and energy of the naturalist who has done so much in so short a time, and in so difficult a locality for work as the inhospitable shores of Kerguelen's Land, or to the University of Berlin for the instructions given before the expedition started, it is not in human nature to forget that the Germans are not the only nation who sent an expedition to that spot. Moreover, although these specimens could not be better placed than as part of the extensive collection now forming at Berlin, and, so long as Prof. Peters has charge of it, will be at all times accessible to all comers, yet Berlin is distant a journey of a day and a half from London, and in consequence the majority of Englishmen must remain as heretofore in ignorance of what a Sea Elephant is like. Why will our countrymen obstinately refuse to take the trifling amount of trouble necessary for the killing, the preparation, and the packing of this and allied marine mammals? Again, why, when an expedition is about to start, do not those in authority give stringent orders for the capture of the mammals that are known to exist in a given locality? Even from a commercial point of view the acquisition of these animals might be advantageously undertaken; as a brisk competition would ensue among all the museums for their possession, if perfect skeletons, in good condition, were to be brought home.

Vienna, Aug. 21 JOHN WILLIS CLARK

P.S.—As a rule, when "Sea Lion" is spoken of in the old voyages to the Pacific and South Atlantic, what we term Sea-Elephant is meant—a true Seal; while our Sea Lion—an *Otaria*—is spoken of as a "Seal."

OUR ASTRONOMICAL COLUMN

VARIABLE STAR (?).—Mr. J. E. Gore, of Umballa, Punjâb, suspects variability in a star "about 2° preceding the 5 m. σ Andromedæ, which Harding shows a 5 m. star, and which is not in Lalande," and he gives as the approximate place for beginning of the present year, R.A. 0h. 2m., and N.P.D. 53° 59′. On looking up the history of this star there will, however, hardly appear sufficient proof of any change of magnitude. Though it does not occur in the reduced Catalogue of Lalande, the star was, nevertheless, observed by him, and the place for 1790 will be found in "Connaissance des Temps," An. vii. p. 423, where the star is called 6 m., and being one of the large numbers of stars the positions of which were communicated by Lalande to Bode, in manuscript, it appears in the catalogue to his large atlas, and is there called E Andromedæ, but a 5 m., with Lalande as authority. Bessel (Zone 386) estimated it 7; it is 6·2 in the "Durchmusterung," and 6·7 in Heis.

THE SOLAR ECLIPSE OF SEPTEMBER 28-29.—This eclipse, which will be visible as a small one in these islands, is annular on the central line, but the track of annular phase upon the earth's surface is such that it appears only one of the established Observatories will be included within it, viz., that of Harvard College, Cambridge, U.S., and here the sun will be little elevated above the horizon. The *Nautical Almanac* contains the times of beginning, greatest phase, and ending, for Greenwich, Cambridge, Oxford, Liverpool, Edinburgh, and Dublin, and from these data the times for any place in England may be readily interpolated on the simple method proposed by Mr. Woolhouse in the "Companion to the Almanac" for 1871; or, for fifty or sixty miles round London the time of first contact, of which alone an observer needs any warning, will be obtained with precision (effect of tabular errors of course excepted) by the following formulæ:—

$$\text{Cos. } w = +\ 0\cdot14193 - [0\cdot13402]\ \text{sin. } l + [0\cdot06273]\ \text{cos. } l,\ \text{cos. } (L + 86^\circ\ 18'\cdot2)$$
$$t = 1\text{h. } 33\text{m. } 0\text{s.} - [3\cdot71112]\ \text{sin. } w - [3\cdot77334]\ \text{sin. } l$$
$$-\ [3\cdot84549]\ \text{cos. } l,\ \text{cos. } (L + 82^\circ\ 41'\cdot5)$$

Here l is the geocentric latitude of the place, L its longitude from Greenwich, + if E., − if W., and t the Greenwich time of first contact; the quantities within square brackets are logarithms.

At Gibraltar, where the eclipse will be about as large as at any point in Europe, it begins at 10h. 35m. A.M. on the 29th, local mean time, and at the time of greatest phase, 11h. 53m., the magnitude of the eclipse is 0·43 (the sun's diameter = 1); the first contact at 79° from the sun's north point towards the west. At Malta there is a small eclipse (0·10), the middle at 1h. 49m. local time.

At the Observatory of Harvard College the annular phase begins at 6h. 21m. 10s. A.M. mean time at Harvard, and continues 3m. 12s., the sun's apparent altitude between 5° and 6°; the eclipse begins about half an hour before sunrise. At New York (Mr. Rutherford's Observatory) the greatest phase, 0·91, occurs at 6h. 10m. A.M. twenty-five minutes after sunrise, the eclipse ending at 7h. 25m. At Halifax, Nova Scotia, the greatest phase, 0·90, is at 6h. 56m., with the sun at an altitude of 11°, and the end of the eclipse at 8h. 5m.

The next annular eclipse of the sun will take place, 1876, March 25, in British Columbia and the Hudson Bay Territory; and the next solar eclipse visible in this country is that of 1880, December 31.

THE MINOR PLANETS.—Eurydice, which has been selected by Prof. Galle as affording at the approaching opposition another opportunity of obtaining an independent value of the amount of solar parallax, will be found very close upon the position assigned in the ephemeris published in the "Berliner Astronomisches Jahrbuch" for 1877; on August 29 the planet was as bright as stars of the tenth magnitude. Fortuna, at the present time, is fully a ninth magnitude, and will be found even with the Berlin chart for Hour 23 of R.A., which is by no means one of the most complete of the series. Metis is another member of this group of planets, at present easily recognised.

D'ARREST'S COMET.—M. Leveau is continuing his researches on the motion of this interesting comet, and has obtained elements which represent with considerable precision the observations in 1851, 1857–58, and 1870; allowance being made for the difficulty of fixing the place of so faint and diffused an object, and for the magnitude of the perturbations due to the action of the planet Jupiter; these perturbations are found to have changed the R.A. of the comet on September 24, 1870, by $-14^{\circ}\cdot 6$, and the declination by $+7^{\circ}\cdot 6$. M. Leveau has employed Bessel's mass for Jupiter, and concludes that it is susceptible only of very small correction. He promises, in a future communication to the Paris Academy of Sciences, to furnish an ephemeris for the next return of the comet to perihelion in the spring of 1877.

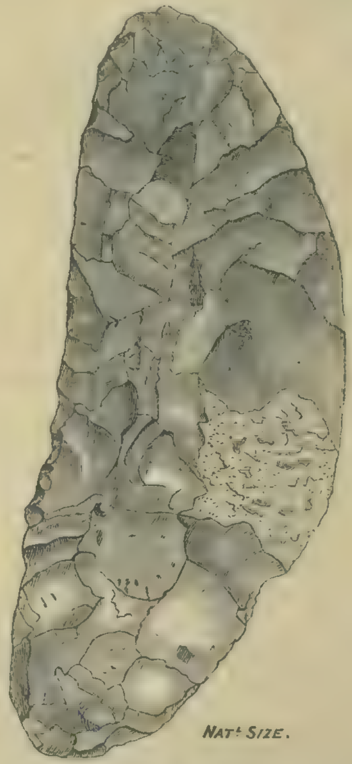
ON THE OCCURRENCE IN NEW JERSEY OF SUPPOSED FLINT SCALPING-KNIVES

IN glancing over a considerable series of American stone implements, we quite naturally expect to find that ever-present feature of the modern Indian's outfit, the scalping-knife. In every collection we recognise the stone axe that preceded the iron tomahawk; the jasper arrow and spear heads, now replaced by metallic ones; while neatly edged flints of various shapes give us cutting implements adapted to all ordinary uses; but not so with the scalping-knife. However large the series, we cannot, at a glance, point out a form of knife peculiarly well adapted for such a purpose, from the several shapes before us. While all are *possible* scalping-knives, none *probably* are so. This, at least, has been my experience until very lately, although I have constantly sought out "probable scalping-knives" from thousands of implements gathered and being gathered in this neighbourhood. Among the hundreds of specimens of flint knives there occurred none that resembled the modern knife, and I supposed that the stone scalpers were similar—the later being modelled from earlier form.

Whether the above inference is correct or not, I have at last detected some specimens that more nearly approach the "ideal form," one such being the flint implement here figured. The result of my collecting labours during the past summer amounts to about five hundred specimens not including fragments, and it is among these that I found the cutting implement above mentioned, with several others like it, both perfect and fragmentary. As the illustration shows, better than any description can do, this slightly curved knife seems moderately well adapted for scalping, as described by Loskiel.[*] He says: "They place their foot on the neck of the victim, seizing the hair with the left hand, and twisting it very tight together, in order to separate the skin from the head; then they cut it all round with a sharp knife, and tear it off." The specimen is a neatly chipped and evenly outlined jasper "implement," having the edges still well defined and sharp. The curved, and I presume cutting edge, is formed by striking off comparatively large flakes, and is better adapted to making a "clean" cut, than the straighter side. The lower end, about one-fourth of the whole length, is somewhat narrower, and while less sharp along its edges, is thinner, and has no median ridge. This portion, very possibly, was inserted into a bone handle as modern Eskimo scrapers now are (vide "Reliquiæ Aquitan." Part ii. p. 14); and if so, we surely have, in the figured implement, one that would conveniently serve as a scalping-knife. In the interest of archæology I should like to experiment with this specimen, but have no available scalp at hand; my own, unfortunately, being quite innocent of hair.

There being no mineral found near here that gives off long thin flakes like true flint or Mexican obsidian, which latter was used for razors by the Mexican Indians, and the shells of our Delaware River unios being too thin and small to serve such a purpose, we must fall back on the jasper and quartz pebbles of the neighbourhood for the material for such knives.

The number of scalping-knives in use at all times must have been considerable, and this fact alone seems counter to my suggestion that the specimen figured may be a scalping-knife, inasmuch as so very few knives of this pattern have been found here. It must be remembered, however, that every warrior would have his knife buried with him, if not killed in battle, when the knife would be lost or stolen; and one such knife would last a lifetime, so that here may be an explanation of their comparative rarity, the great mass of them still lying in the nearly obliterated graves. Or, like smoking pipes, they may have been handed down from one generation to another, their peculiar use rendering them sacred in the eyes of the savage; and when buried with the other "personal effects" of the dead warrior, like the buried pipes, they may have been exhumed by those too lazy to make or too poor to purchase for themselves. That graves were thus robbed is certainly true.



In the graves that I have been fortunate enough to examine I have found cutting implements of jasper, quartz, and slate; and, twice, jasper specimens like the above. These graves to which I refer are now only to be detected by the presence of such imperishable relics as stone implements, pottery, and by the discoloration of the soil. Judging from appearances, the body was placed at full length *on the surface of the ground*, the weapons placed with it being grouped together on the right side, and a vase of rude pottery filled with a red powder at the feet. The body was then probably covered with bark, or skins of animals. Of course the decomposition would go on very rapidly, and soon no trace remain except the bones and stone implements; then the weapons only. My reason for believing these graves to be "surface" burials is in consideration of the fact that the inhumed weapons and discoloured dirt are only from three to six inches beneath the sod, and this accumulation of soil is that arising from the annual decay of the preceding summer's foliage, coupled with the dust that would naturally gather around any object lying on the ground. The graves such as I have described, too, are only to be found on the slopes of grassy hill-sides that as yet have not been disturbed by the plough. I have never seen such a grave in a ploughed field. Such have been long obliterated; and the relics now found in fields may or may not be those that were buried with their prehistoric owners.

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[*] Mission among North American Indians. London, 1794; P. 149.

In conclusion, then, seeing that the custom of scalping was not introduced with a knowledge of metals, but preceded it, it is certain that some stone implement was used; and if in a large series of cutting tools we find some that bear resemblance to the modern form, then it is fair to presume that these, and these principally if not wholly, were those formerly in use.

A few words concerning this custom of scalping: is it peculiarly North American? I should be much pleased to learn from some correspondent of NATURE what other races, if any, have the same practice among them. Inasmuch as the Indian custom required of every warrior incontestable proof of his success in battle or in single combat, and considering that a warrior would frequently attack singly some member of a hostile tribe (See Catlin's "North American Indians"), it seems quite a natural method of showing beyond doubt that the claimant had indeed killed his foe. To produce any portion of another's clothing, or his weapons, would not prove the enemy to have been killed; to produce his scalp shows that such was certainly the case, as the instances of survival after scalping are too few to be considered. Did the custom originate in North America, or was it brought from beyond our borders?

CHAS. C. ABBOTT

Trenton, New Jersey, Aug. 7

THE SLIDING SEAT FORESHADOWED

IT is a curious and suggestive fact that nearly all the most ingenious and important mechanical inventions find their representatives in the human frame; consequently, the more we investigate the wonderful mechanism of man's body, the more insight may we expect to get into the principles necessary for the most perfect adaptation of means to ends. Whether we take the lever, the pulley, the inclined plane, the spiral or the curved spring, the arch, or any other simple uncomplicated contrivance adapted with a view to securing strength, or motion, or elasticity, we find it represented in animal mechanics, and arranged sometimes simply, sometimes in a more complex form, in a manner and with a result far more wonderful than ever produced from the most ingenious conceptions, of man's brain.

Of late years the application of the sliding seat to rowing has attracted considerable attention, and although it is beyond the purpose of this paper to consider fully the advantages gained by its application, it will, I think, be necessary to make some reference to what appear to be its principles before we inquire whether it can be traced as existing in certain of the joints.

In the mechanics of rowing we may look upon the hips and spinal column as theoretically a firm, unyielding lever (Fig. 3, S), since it is knit together by the power of the muscles in a man thoroughly trained. The object of this fixedness is evidently to avoid the loss of power and time which would occur if parts had to be strung together preparatory to the pull as the oar catches the water. This spinal lever has its fulcrum at what we call the tuberosities of the ischia (t), or in other words at the points of contact of the body with the seat, and the motive power is placed in the muscles of the back and those of the thigh. The weight to be moved will be acted upon through the arms at the junction of the upper extremities with the spinal lever.

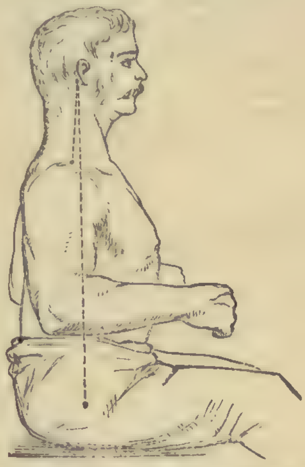

FIG. 1—Sitting at rest. Showing tip of shoulder behind the line from mastoid process to hip.

As the body moves forwards, the lever formed by the spine rotates round the tuberosities which constitute the fulcrum, and which slide forward at the same time. The knees are consequently slightly bent or separated. As the oar catches the water the body is brought back to the perpendicular by the action of the muscles of the back and those of the thigh, and the lower end of the lever is at the same time carried bodily back a distance of about eight inches.

The whole principle appears to be that of a sliding fulcrum, and the peculiar result seems to be that a greater reach is given with less bending forward of the body; for to obtain the same length of stroke the body must either be bent forward at a much more acute angle or carried back beyond the perpendicular. An increased bending forwards, it must be borne in mind, must interfere with the respiration in a long-continued strain as in a race, and therefore with the staying powers of the individual.

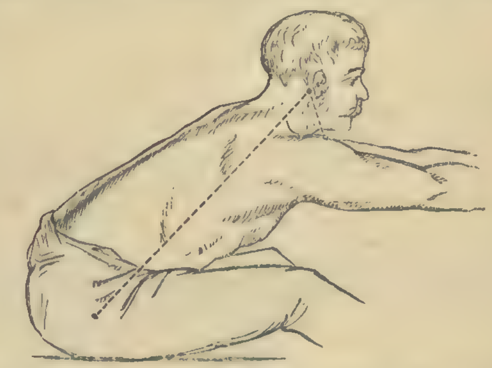

FIG. 2.—Forward movement in rowing, showing tip of shoulder far in front of the line from mastoid process to hip.

If, on the other hand, the body be carried backwards beyond the perpendicular, the power of recovery is diminished, and far greater work is thrown upon the muscles of the trunk and lower limbs.

With a sliding seat, therefore, we seem to have a provision for greater range of movement at the distal end of the lever. In the upper extremity it seems to me we find the same principle at work, and if so it is curious that we should have adopted as a novelty or an invention what nature has provided us with in other points, that we should apply to the lower extremities in rowing the same principle that already exists in connection with the upper, and is brought into action perhaps especially in rowing, and that this should have been done unknowingly.

The bony framework of the upper limb is connected with that of the trunk at only one point, the inner or sternal end of the collar-bone, and it is round this point that movement occurs. The greatest freedom of motion, however, takes place at the shoulder-joint, and as this joint is, moreover, at the apparent junction of the free limb with the body, the movements here are generally looked into to the exclusion of those at the junction of the collar-bone and breast-bone. But the importance of the latter will at once be recognised when it is considered that the collar-bone and shoulders rotate round the upper part of the breast-bone, and according to their length and mobility will move through a larger or smaller arc.

The amount of movement between the extremes of forward and backward positions of the shoulder (Figs. 1 and 2) can be readily tested, and I have found that the average of several observations on different individuals, taken at the tip of the shoulder, the chest being absolutely fixed, is from six to seven inches; or, in other words, the tip of the shoulder moves backwards and forwards to that extent between the extremes of forward and backward movement.

Similarly in the vertical line a large extent of motion occurs, the difference between the extremes being on the average four inches. Now, when it is noticed that the arm moves at the shoulder-joint with an extraordinary amount of facility, and that its chief motions as a mechanical appendage to the trunk occur in that articulation, we are led to look upon the arm, fore-arm, and hand as a compound lever, working with its one end free and the other rotating in the socket of the shoulder-joint.

In the lower extremity we also find the compound lever working with one end somewhat similarly in a socket. In the case of the upper, however, the socket is a movable one, slipping backwards and forwards freely with the limb and strangely increasing its range of motion; still capable of being fixed firmly in position by the superficial muscles of the back. But in the lower extremity the socket is fixed, and there is no provision for sliding, since strength rather than range of motion is wanted, and where greater range of motion is needed, as in rowing, there a blind application of the principle found in the upper extremity has been only recently effected.

I have referred only to the sliding fulcrum at the shoulder as seen on both sides equally, and as is best exemplified in the position of the arms in rowing, when however the whole trunk also moves; but it must be borne in mind that a still further sliding of the fulcrum is constantly taking place when one hand alone is used, for the chest is also turned towards the object to be reached, by rotating and flexing the spine. The advantage of the vertical motion is seen in such actions as bell-ringing, weight-lifting, &c. Moreover it must be noticed that when the lever forming the arm is raised from the side to a right angle with the body it has reached its limit of motion at the shoulder-joint, and that subsequently the upward motion occurs in the collar-bone, since the top of the shoulder checks the further movement of the arm upwards. There is in connection with the lower extremity a somewhat similar mechanical arrangement, which is not however brought into play so fully as in the upper. The sockets of the hip-joints can be brought forward by a rotation of the spine. This is especially noticeable in those who are prevented from using their feet freely, where therefore the elasticity and spring which are so wonderfully provided in the foot are lost, and the length of stride is obtained by the utmost use of mechanical advantages commonly unused in connection with the hip. Ploughmen and labourers whose feet are cased in unyielding clogs walk from the hips, or in other words they slide the fulcrum forwards by rotating the spine, whereby they gain a larger stride.

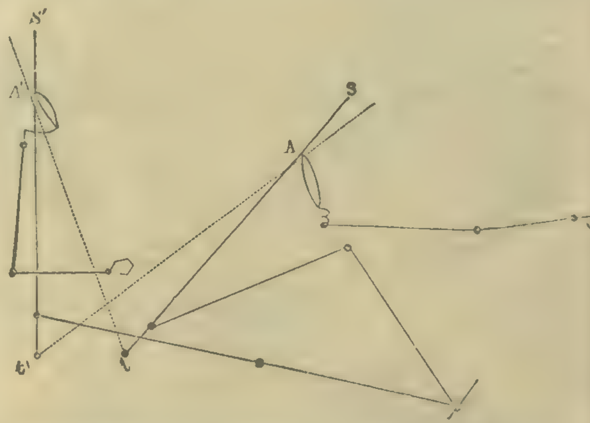

FIG. 3.—Diagram to show sliding-seat action at the shoulders. In the forward position the arm is thrown forward so that the shoulder is about three to four inches in front of the spinal line S A *t*. In the backward position the same point is about one to two inches behind the same line S′ A′ *t′*, the whole movement occurring at the sterno clavicular articulation. The sliding of the tuberosities of the ischia backwards in this movement is equal to about eight inches (*t* to *t′*). The dotted lines show the degree of forward or backward movement of the body which would be necessary to gain the same range of arm-movement, if the tuberosities were fixed and no sliding were used.

Such then are some of the curiosities of animal mechanics seen in our wonderful framework, and the subject would repay us in interest as well as in usefulness if studied more by those who are concerned in mechanics generally. W. W. WAGSTAFFE

St. Thomas's Hospital

THE BRITISH ASSOCIATION

BRISTOL, *Tuesday Night*

OUR meeting has nearly run its course, and may so far be pronounced a great success. Brilliant weather has been added to hospitality and to skilful direction, and has produced a generally harmonious result. We may certainly expect that the Association, not less than the Bristol people, will desire a repetition of the visit within somewhat fewer than forty years.

Partly owing to the comparative weakness of the President's voice, and partly to the deficient acoustic properties of Colston's Hall, the President's address was not quite so successful as it might otherwise have been. Even Prof. Tyndall had to strain his voice considerably in order to be well heard. Perhaps the most forcible ideas left on the mind by Sir John Hawkshaw are his patience and caution, his dislike for taking leaps in the dark, and his eager desire to take steps in advance when the way can be seen with tolerable clearness. His modesty in not referring to any of his own great achievements, when pertinent references might have been made, was very noticeable. Prof. Tyndall, in his admirable opening address, spoke as follows:—

"It is my privilege to introduce to you as your president for the coming year Sir John Hawkshaw, a name celebrated throughout the world for the practical application to works of the greatest magnitude of some of these sciences which it is the function of this Association to foster and advance. In him, I doubt not, you will have a wise and prudent head, a leader not likely to be caught up into atmospheric vortices of speculation, about things organic or inorganic, about mind or matters beyond the reach of mind, but one who, struggling, Antæus-like, with his subject here to-night, will know how to maintain throughout a refreshing contact with his mother earth. I have looked forward for some time to the crowning act still in prospect of his professional career, to give our perturbed spirits rest in crossing the Channel in visiting our fair sister France. But pending that great achievement, it is his enviable lot to steer this British Association through calm waters to a haven of, at all events, temporary rest—rest all the more sweet and needful from the tempestuous weather which rasher navigators who preceded him thought it their duty to encounter rather than to avoid. To his strong hand I commit the helm of our noble barque, wishing him not only success, but triumph in that task he has undertaken, and which I now call upon him to fulfil."

Both papers and discussions have been of very high interest. Some of the papers mark epochs in science: such as Prof. Cayley's, on the theory of chemical combinations. The Transit of Venus, the proposed flooding of the Sahara, the Deep-sea Fauna, oceanic circulation, Murchison's classification of Palæozoic strata, the ethnography of races at the commencement of civilisation, the Channel and Severn tunnels, the coal question, and railway safety, may be mentioned among the chief subjects of wide interest. Social subjects have had a full share of attention, considering the pre-scientific stage in which most of them are.

Some of the personally interesting scenes have been rather notable—as when Sir W. Thomson, in relation to Mr. Croll's assault on Dr. Carpenter's doctrines of oceanic circulation, pronounced that Dr. Carpenter's demonstration was most conclusive and his reasons irrefragable; when Prof. Hull, criticising Prof. Hughes, said he had never before heard so many heresies in so few minutes; if it were possible for his hair to stand on end it would immediately begin to friz out from the centre to the circumference; and when Mr. John Evans, Canon Tristram, and Canon Rawlinson combined to give a wholesome exposition of sound doctrine in ethnological subjects and of the relative value of various kinds of evidence, after the reading of a paper which was destitute of scientific principles.

Dr. Carpenter was as happy as ever in his lecture to working men, on "A Piece of Limestone." He had a great audience of unmistakeable working men, with whom he placed himself in most cordial *rapport*.

Mr. Samuel Morley, M.P., after the lecture, said the subjects of the Association meeting were those in which working men were deeply interested, for the competition of manual labour must give way to the competition of intellect. Men who wanted to get on, and masters who wished to hold their own, must unite in promoting, by their own investigation, the knowledge and the philosophy which were to be found in, or connected with, their various manufactures. Mr. Bramwell's lecture was of a useful kind, but defended engineers and railway directors perhaps too much.

Mr. Spottiswoode's lecture on the Colours of Polarised Light was very successful both in exposition and in experimental illustration. The lecturer used a splendid instrument, in which two Nicol's prisms of great size, and beautifully cut, serve the purpose of polariser and analyser, with which he was able to secure the maximum of illumination with a large field of view. The meeting was made more interesting by Sir John Hawkshaw's announcement that the President of the French Association sitting at Nantes had that day telegraphed an expression of their good will and of their wishes for the success of the Bristol meeting. His call for a manifestation of their hearty reciprocation of those feelings was responded to with enthusiasm.

Since no other sectional address was delivered on Friday morning, Prof. Rolleston had a crowded audience to hear his address to the Anthropological Department of Section D. His auditors had one of the greatest treats the meeting has afforded, and the vigorous individuality, the vivacity of thought and action, the boldness and fearlessness, and the wit, scholarship, and research of the Professor must have been vividly impressed on many. At the commencement of the address, when he had to give directions for the opening of an extra door in order to allow a crowd of persons in the corridor outside to hear him, his sudden sally describing their desire to enter "for reasons inscrutable to me" was highly characteristic and appreciated; and the passages in which he spoke of the relative capacity of female crania compared to men's in former and present days, the toleration of nuisances and epidemics, the deterioration and improvement of races, and the value of missionary labours, were listened to with deep attention.

The microscopical *soirée* on Thursday evening was a very great success, and the Association owes its hearty thanks to Messrs. W. Tedder and J. W. Morris, the secretaries respectively of the Bristol and Bath Microscopical Societies, and to the members of those societies. A bold idea was well carried out, viz., that of exhibiting chiefly living objects. The 110 microscopes were arranged in classified divisions, devoted to Crustacea, Arachnidans, Insecta, marine and fresh-water fauna, ciliary action, vertebrate circulation, vegetable circulation, fertilisation of flowers, Cryptogamia, microspectroscopes, &c. The idea of practically illustrating Sir John Lubbock's "Fertilisation of Flowers by Insects" was novel, and so far carried out as to give a vivid idea of the processes to those who were previously unfamiliar with them. The geological division included an exhibition of the perennial *Eozoon canadense*, which must be exhibited again and again to live down the hostility to its animal nature. Altogether the exhibition was a great evidence of scientific enthusiasm, which had led many ardent students to make special dredging and fishing expeditions both in inland and marine waters.

The Museum of the Bristol Museum and Library Society has been a very considerable attraction. Bristol is exceptionally fortunate in its museum, to which the local Naturalists' Society, the Clifton Zoological Society, and many travellers and sea-captains have contributed. In Zoology it contains many valuable specimens, such as the large Gorilla from the River Gaboon, W. Coast of Africa, both the skeleton and stuffed skin being well preserved; the fine skeletons of *Manatus australis* and *otaria* from the Chilian coast; the ancient Peruvian human skulls from Arica and Islay; the very large Green Turtle's skeleton from Ascension Island. The fossil collection is still more notable, for it contains many unique and type-species of carboniferous fishes. The grand collection of Ceratodus teeth, rescued recently from purchase by Americans, is placed close to a specimen of *Ceratodus forsteri* from Australia, with jaws and teeth detached. The additions to the Museum buildings now in course of erection, which include the fine lecture-theatre in which Section C is accommodated, have enabled the local committee to find room for a local loan collection of natural history, in which Bristol ornithology and entomology are specially well represented.

The rich local flora is well represented by the efforts of the botanical members of the Naturalists' Society. Sixty comparatively rare species are exhibited. A convenient handbook to the local museum and temporary additions has been published. Messrs. Tawney, Stoddart, Wheeler, Derham, and many others have worked zealously to make this one of the most successful of the *et ceteras* at this meeting.

The temporary museum of objects illustrating papers or reports read before the Sections, has been well stocked, and superintended by Mr. J. E. Taylor.

In accordance with resolutions presented at the Belfast meeting, the Council this year memorialised Government to take action in reference to several subjects connected with the advancement of science. First, in March this year, Prof. Tyndall addressed Government in the name of the Council, urging upon them the desirableness of continuing solar observations in India. In accordance with this request, Lord Salisbury urged upon the Governor-General of India the advisability of establishing at Simla a Solar Observatory to continue the work which is to be carried on at Roorkee in 1875-6. Secondly, the Council urged upon Government the importance of appointing naturalists to vessels engaged on the coasts of little-known parts of the world. The Admiralty thanked the Council for their suggestion. The third resolution was that the Council be requested to take such steps as they may think desirable with the view of promoting any application that may be made to her Majesty's Government by the Royal Society for a systematic physical and biological exploration of the seas around the British Isles. The Council have deferred the consideration of this resolution until action be taken by the Royal Society. The fourth resolution supported the equipment of an Arctic Expedition: with what success the efforts in this direction have been crowned, everybody knows.

The balance-sheet of the Association for 1874-5 shows a balance in hand, at the commencement, of 714*l.*; receipts from subscriptions, 2,324*l.*; dividends, 238*l.* Payments were—for Belfast meeting, 405*l.*; Report of Bradford meeting, 689*l.*; salaries, 470*l.*; rent, &c., 104*l.*; grants, 960*l.*; balance in hand, 624*l.* The estimate for 1875-6 was as follows:—Receipts at Bristol, 2,316*l.*; supposed additional members' subscriptions, 230*l.*; total estimated income, 3,438*l.*; probable expenses at Bristol, 430*l.*; printing Belfast Report, 720*l.* A balance of 1,713*l.* was shown, from which grants might be made. The number attending the meeting is approximately as follows:—Life members, 265; annual members, 385; associates, 860; ladies, 670; foreign members, 16; total, 2,196. Number at Belfast, 1,938.

Glasgow has been chosen as the place of meeting for next year, and Plymouth for 1877.

Sir Robert Christison has been chosen President-elect of the meeting at Glasgow. The Vice-presidents for the Glasgow meeting were elected as follows:—The Duke of Argyll, Sir W. Stirling Maxwell, Sir William Thomson, the Lord Provost of Glasgow, Dr. Allen Thomson, and Prof. A. C. Ramsay. The general secretaries and treasurer were re-appointed, and the Glasgow meeting was fixed to commence on Wednesday, Sept 6, 1876.

REPORTS

The Report of the Committee on Specific Volumes, consisting of Professors Roscoe, Balfour Stewart, and Thorpe, was presented by Dr. Thorpe.—The committee have undertaken to report on the validity of Kopp's laws concerning the specific volumes of liquids. The greater portion of the experimental part of the investigation has been finished, but the reduction and calculation of the results have still to be completed, and the committee will not be able to present their final report until the next meeting of the Association.

Report on Dredging off the Coast of Durham and North Yorkshire in 1874, by David Robertson and G. S. Brady.—The greatest number of novelties occurred among the Copepoda, twenty-eight species being new to science, and eleven others new to British records. Twenty-one species are added to the list of testaceous mollusca prepared by the late Mr. Alder; other orders afforded new species. Much interesting information was obtained about the distribution of the species. While the testaceous mollusca show distinctly boreal characters, in the Ostracoda and Foraminifera this is by no means so apparent. The reporters do not suppose that a cold arctic current is the only or even perhaps the chief agent in the continued existence of this peculiar Northumbrian molluscan fauna; consequently some more local circumstances must be looked to as the chief causes of the retention of the species in question over particular circumscribed areas. Copious particulars of the dredgings are given, with full lists of species.

Report on the Zoological Station at Naples.—At present the station possesses twenty-one working tables, of which seventeen are occupied or bespoken. Each table is in itself a condensed laboratory; it is supplied with a number of small working aquaria, with a constant stream of sea-water. The animals for study are provided by the station. The large aquarium of the station can also be used by students for suitable purposes. The library has already become a fairly extensive one, being especially rich in embryological works. Students may accompany and take part in the fishing and dredging expeditions of the station. The large aquarium is partly a popular exhibition, which helps to support the station. The staff consists of Dr. Dohrn, the general director; Dr. Eisig, his responsible assistant; two other scientific assistants, one to superintend the large aquarium and the fishing, and the other to arrange for the collection and preservation of animals; three engineers, four house servants, and four fishermen. The work facilitated by the station is of the following kinds:—1. Morphology and embryology of marine animals; this requires that students should visit the laboratory at the periods when the specimens required can be obtained. 2. Physiological investigation of marine animals, so little worked at hitherto. 3. Study of the habits of marine animals. 4. Systematic investigation of marine fauna and flora of the Mediterranean in the vicinity of Naples. Few tasks are more promising than a thoroughly systematic dredging of the Bay of Naples. Animal forms naturally occupy the chief attention at the station, but no less facilities are offered for the study of marine vegetable forms. This is significantly indicated by the fact that Prof. Cohn, of Breslau, and Prof. Reineke, are to visit the station next session to carry on algological researches. 5. Physical investigation of the sea in the neighbourhood of Naples, with the periodic appearance and disappearance of certain animals in shoals or large numbers. 6. Experiments on breeding and preserving delicate marine organisms in a healthy condition. 7. Transmission of specimens to investigators at home.

The scientific results of the station have been very considerable, and the students have included some of the most distinguished biologists. Next winter Dr. Dohrn proposes to begin a series of annual accounts of the work done at the station. When all the tables are taken up, it is calculated that with strict economy the institution will pay its working expenses. But it would be of the highest value if governments, universities, and public institutions would support the station to a much greater extent than at present.

Intestinal Secretion.—A second report was presented by the Committee on Intestinal Secretion—Dr. Brunton and Dr. Pye Smith. The report detailed a number of experiments which the committee had undertaken, and which were considered to prove the absence of influence on Intestinal Secretion through the splanchnic nerves, the pneumogastrics, the sympathetic above the diaphragm or the spinal marrow; and the probable influence of the ganglia contained in the solar plexus, though certainly not of the two semilunar ganglia exclusively. Also the independent occurrence of hæmorrhage and of paralytic secretion appeared, in the view of the committee, to point to a separate nervous influence on the blood-vessels and the secreting structures of the intestines. They also observed the occurrence of vomiting after section of both splanchnics and vagi.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS

The Section was well filled to hear Prof. Balfour Stewart's address, in spite of the great counter attraction offered by Mr. Froude's address and experiments which were taking place simultaneously in the room underneath, Section G. After the conclusion of the address, and after a cordial vote of thanks, moved by Col. Strange and seconded by Rev. R. Mason, had been accorded to Prof. Stewart, Prof. Everett gave in a few words the report of the Underground Temperature Committee, specially referring to the observations recently made at the St. Gothard Tunnel, at Chiswick, and at Swinderby near Lincoln, Prof. Guthrie then showed his experiments on the measurement of the rate of wave progress. His apparatus consisted of three deep troughs, two circular and one rectangular, and the steadiness of the motion in each was remarkable; he compared the velocities of the waves with the times of vibrations of pendulums, and verified that in different sized troughs the rate varied inversely as the square root of the diameter. The experiments excited a good deal of interest.

The Rev. S. J. Perry, of Stonyhurst College (one of the members of the expedition to Kerguelen to observe the Transit of Venus), read a paper on that event. Father Perry illustrated his remarks by diagrams of the sun and the planet, as seen from various stations, and gave a very interesting explanation which was attentively listened to. He said that although much prominence had not been given to the idea, he believed that a very important reason why so much expense was gone into in the expedition was that the distance of the earth from the sun entered into the calculation of lunar tables. The observations were not of any striking nature; they were simply to watch a black spot pass across the sun. There was nothing exciting about it, except that when the observations had to be taken they had to be very careful about the precise time, and they had to observe the spot during the whole time of its passage. Having pointed out with reference to his diagrams the reason why the different stations were chosen, he denied the assertions that had been made that Sir George Airy neglected Halley's method of observation for Delile's; the truth was he had rightly decided in favour of Delile, but he had not neglected Halley. With regard to the (Halleyan) stations in the extreme north, they were left to the care of the Russians, and the English, French, Americans, Germans and others occupied in the southern hemisphere. As it was mid-winter, the sun was very nearly on the line of the southern tropics and nearly vertical at ingress over the eastern border of Australia. There were primarily five English Government expeditions, but as these were subdivided, there were, including private observers and those of India and the Colonies, about twenty English stations of observation. His station was Kerguelen, to the south-west of Australia, and after arriving there they found that the Americans had taken the station recommended by the members of the *Challenger* Expedition, but in spite of that they had plenty of time to look about the island (which was a very barren place, about ninety miles by forty-five), and they were fortunate enough to get a much better position than the Americans, after all, by going a little to the south-west. They had been told before they went out that there was always a mist over the island, but, though that might be the case in the north of the island, which had been chiefly visited before, it did not apply to the south while they were there, and they had not more mist than there would have been in London. On the morning of the transit, which they expected to begin at 6·30, they rose at four, and at once made preparations for the day's work. They were divided into three parties, and were so placed that, with the Americans, they formed four parties, about eight miles distant from each other. They saw the sun very well until after six o'clock, at the first (his own) station, until almost the time that Venus was coming on to the sun's disc, and they had the external contact as well as could be expected, for there never could be absolute certainty with regard to such a point. They continued very well until they had taken the bisection by the planet of the sun's disc, but then there was just one little cloud that came and placed itself right over the planet and remained till ten minutes after the commencement of the transit. At the other stations they were able to make observations of the ingress. At his station they were able to get observations of the internal and external contact at egress, and a few photographs. Father Perry added particulars of the result of observations at the other stations as far as could be ascertained, and narrated his experience of a cyclone in the Indian Ocean on the homeward passage. He added that during their stay on the island they not only made astronomical observations, but also a series of magnetic and meteorological observations; and the Rev. A. E. Eaton was sent by the Royal Society to study the botany of the island.

In answer to a gentleman, Father Perry said if they got the results of the observations in seven years' time they would be very lucky, as they had first to determine their longitude, and that occupied a very long time.

Prof. Osborne Reynolds read a paper *On the Refraction of Sound by the Atmosphere*, in which he remarked that in previous papers he had pointed out that the upward diminution of temperature in the atmosphere (known to exist under certain circumstances by Mr. Glaisher's balloon ascents) must refract and give an upward direction to the rays of sound which would otherwise proceed horizontally, and it was suggested that this might be the cause of the observed difference of the distinctness with which similar sounds were heard on different occasions, particularly of the very marked advantage that the night has over the day in this respect. On this subject he had made a series of experiments. He mentioned a case in which at sea, when leaving a yacht in a small boat, for the purpose of making experiments on sound, those in the yacht and the boat were able to call to one another, and he heard at a distance of three-and-a-half miles, and that the hiss and report of a rocket sent up from the yacht was heard at a distance of five miles. Also on the same occasion the barking of a dog on shore, which was eight miles distant, was heard, and the paddles of a steamer which must have been fifteen miles off were distinctly audible. Prof. Reynolds remarked that the distinctness with which sounds of such comparatively low intensity could be heard was perhaps beyond anything definitely on record, although remarkable instances of sounds heard a long way off were occasionally heard of. As the result of a series of experiments made by means of an electric bell, Prof. Reynolds found that when the sky was cloudy and there was no dew, the sound could invariably be heard much further with than against the wind; but when the sky was clear, and there was a heavy dew, the sound could be heard as far against a light wind as with it. On one occasion in which the wind was very light and the thermometer showed 39° at one foot above the grass, and 47° at eight feet, the sound was heard 440 yards against the wind and only 270 yards with it.

The paper by Prof. G. G. Stokes and Dr. J. Hopkinson, *On the Optical Properties of a Titano-silicic Glass*, we give *in extenso* on account of its importance. At the meeting of the Association at Edinburgh in 1871, Prof. Stokes gave a preliminary account of a long series of experiments in which the late Mr. Vernon Harcourt had been engaged, on the optical properties of glasses of a great variety of compositions, and in which since 1862 Prof. Stokes had co-operated with him.[*] One object of the research was to obtain, if possible, two glasses which should achromatize each other without leaving a secondary spectrum, or a glass which should form with two others a triple combination; an objective composed of which should be free from defects of irrationality without requiring undue curvature in the individual lenses. Among phosphatic glasses, the series in which Mr. Harcourt's experiments were for the most part carried on, the best solution of this problem was offered by glasses in which a portion of the phosphoric was replaced by titanic acid. It was found, in fact, that the substitution of titanic for phosphoric acid, while raising, it is true, the dispersive power, at the same time produces a separation of the colours at the blue, as compared with those at the red end of the spectrum, which ordinarily belongs only to glasses of a much higher dispersive power. A telescope made of discs of glass prepared by Mr. Harcourt, was, after his death, constructed for Mrs. Harcourt by Mr. Howard Grubb, and was exhibited to the Mathematical Section of the late meeting in Belfast; this telescope, which is briefly described in the Report,[†] was found fully to answer the expectations that had been formed of it as to destruction of secondary dispersion.

Several considerations seemed to make it probable that the substitution of titanic acid for a portion of the silica, in an ordinary crown glass, would have an effect similar to that which had been observed in the phosphatic series of glasses. Phosphatic glasses are too soft for convenient employment in optical instruments, but should titano-silicic glasses prove to be to silicic what titano-phosphatic glasses have been found to be to phosphatic, it would be possible, without encountering any extravagant curvatures, to construct perfectly accurate combinations out of glasses having the hardness and permanence of silicic glasses; in fact, the chief obstacle at present existing to the perfection of the achromatic telescope would be removed, though naturally not without some increase to the cost of the instrument. But it would be beyond the researches of the laboratory to work with silicic glasses on such a scale as to obtain them free from striæ, or even sufficiently free to permit of a trustworthy determination of such a delicate matter as the irrationality of dispersion.

When the subject was brought to the notice of Mr. Hopkinson, he warmly entered into the investigation, and thanks to the liberality with which the means of conducting the experiments

[*] Report for 1871. Transactions of the Sections, p. 38.

[†] Ditto for 1874. Transactions of the Sections, p. 26.

were placed at his disposal by Messrs. Chance Brothers, of Birmingham, the question may perhaps be considered as settled. After some preliminary trials, a piece of glass free from striæ was prepared of titanate of potash mixed with the ordinary ingredients of a crown glass. As the object of the experiment was merely to determine in the first instance whether titanic acid did or did not confer on the glass the universal property of separating the colours at the blue end of the spectrum materially more, and at the red end materially less, than corresponds to a similar dispersive power in ordinary glasses, it was not thought necessary to employ pure titanic acid; and rutile fused with carbonate of potash was used as titanate of potash. The glass contained about seven per cent. of rutile, and as none was lost, the percentage of titanic acid cannot have been much less. The glass was naturally greenish from iron contained in the rutile; but this did not affect the observations, and the quantity of iron would be too minute sensibly to affect the irrationality.

Out of this glass two prisms were cut. One of these was examined as to irrationality by Prof. Stokes, by his method of compensating prisms; the other by Mr. Hopkinson, by accurate measures of the refractive indices for several definite points in the spectrum. These two perfectly distinct methods led to the same result, viz., that the glass spaces out the more as compared with the less refrangible part of the spectrum no more than an ordinary glass of similar dispersive power. As in the phosphatic series, the titanium asserts its presence by a considerable increase of dispersive power; but, unlike what was observed in that series, it produces no sensible effect on the irrationality. The hopes therefore that had been entertained of its utility in silicic glasses prepared for optical purposes appear doomed to disappointment.

A paper was read by Mr. J. A. Fleming, *On the Decomposition of an Electrolyte by Magneto-electric Induction*. When a solid conductor is moved in a magnetic field induced currents are created in it. In a solid these expend themselves partly or wholly in producing heat in the conductor. The paper was occupied with an examination of the effect produced on electrolytes under the same circumstances, viz., when made to flow or move in a magnetic field: experiments were described to show first that induced currents are produced under these conditions in electrolytes, and then that the electrolyte is to some extent decomposed by these currents.

Dr. Moffat, in his paper *On the apparent connection between Sunspots, Atmospheric Ozone, Rain, and Force of Wind*, stated that in discussing ozone observations from 1850 to 1869, he had observed that the maxima and minima of atmospheric ozone occurred in cycles of years, and that he had compared the number of new groups of sunspots in each year of these cycles with the quantity of ozone, and the results showed that in each cycle of maxima of ozone there is an increase in the number of new groups of sunspots, and in each cycle of minima a decrease. He also gave a table to show that the years of maximum ozone and number of sunspots were generally distinguished by an increase in the quantity of rain and the force of the wind.

Sir W. Thomson's paper *On the effects of Stress upon the Magnetism of Soft Iron* was a continuation of two that had been read before the Royal Society. In the physical laboratory at Glasgow University he had stretched steel and soft iron wire about twenty feet long from the roof. An electro-magnetic helix was placed round a few inches of the wire, so that the latter could be magnetised when an electric current was passed through the former; the induced current thus produced in a second helix outside the first being indicated by a reflecting galvanometer. When steel wire was used, the magnetism diminished when weights were attached to the wire, and increased when they were taken off; but when specially made soft iron wire (wire almost as soft as lead), the magnetism was increased when weights were put on, and diminished when they were taken off. Afterwards he discarded the electrical apparatus, and by suspending a piece of soft iron wire near a magnetometer consisting of a needle, a small fraction of a grain in weight, with a reflecting mirror attached, the wire was magnetissed inductively simply by the magnetism of the earth, and changes in its magnetism were made by applying weights and strains, the changes being then indicated by the magnetometer.

Prof. W. F. Barrett read a paper *On effects of Heat on the molecular structure of Steel Wires and Rods*, in the course of which he said he found that if steel of any thickness be heated by any means, at a certain temperature the wire ceases to expand, although the heat be continuously poured in. During this period also the wire does not increase in temperature. The length of time during which this abnormal condition lasts varies with the thickness of the wire and the rapidity with which it can be heated through. It ceases to expand, and no further change takes place till the heat is cut off. When this is done the wire begins to cool down regularly till it has reached the critical point at which the change took place on heating. Here a second and reverse change occurs. At the moment that the expansion occurs, an actual increase in temperature takes place sufficiently large to cause the wire to glow again with a red-hot heat. It is curious that this after-glow had not been noticed long ago, for it is a very conspicuous object in steel wires that have been raised to a white heat and allowed to cool.

Mr. Braham exhibited some experiments on magnetised rings, plates, and discs of hardened steel, and also experiments on air, hydrogen and oxygen.

SECTION D.

BIOLOGY.

OPENING ADDRESS BY DR. P. L. SCLATER, M.A., F.R.S., F.L.S., PRESIDENT.

On the Present State of our Knowledge of Geographical Zoology.

In the office, which I have now held for more than sixteen years, of Secretary to the Zoological Society of London, I have been not unfrequently requested by our members and correspondents in various parts of the world to furnish them with information as to the best works to be consulted on the zoology of the countries in which they are respectively resident, or which they are about to visit. With the well-furnished library of the Zoological Society at my command this is not usually a very difficult task, so far as publications are actually in existence to supply the desired information. I am also frequently asked to point out the principal deficiencies in our knowledge of the animals of particular countries. This is also a not very difficult request to reply to, although it is somewhat embarrassing on account of the very imperfect information which we still possess of geographical zoology generally, and the largeness of the claims I am therefore constrained to put forward for the attention of those who make such inquiries. Great, however, has been the progress made of late years towards a more complete knowledge of the faunas of the various parts of the world's surface. Expeditions have been sent out into countries not previously explored; collections have been formed in districts hitherto little known; and many general works have been published, combining the results of previous fragmentary knowledge on this class of subjects. Under these circumstances I have thought that such an account as I might be able to give of the general progress that has been recently made towards a better knowledge of the zoology of the various parts of the earth's surface, accompanied by a series of remarks upon the best available authorities to be consulted upon such subjects, might supply a want which, as above mentioned, I know by personal experience is often felt, and at the same time would form a not inappropriate address from the chair which I have now the honour to occupy.

I must premise, however, that my observations must be restricted mainly to the terrestrial members of the sub-kingdom Vertebrata. To review the recent progress of our knowledge of the various sections of invertebrate animals in different countries would be beyond my powers, and would inordinately enlarge my subject. Besides, it is certain that the higher classes of animals have occupied the principal attention of recent writers on geographical zoology, and it is with their distribution that we are best acquainted.

Taking, therefore, the seven great regions into which the earth's surface may be most conveniently divided for zoological purposes one after another, I will endeavour to point out our leading authorities on the Mammals, Birds, Reptiles, Batrachians, and Fishes of each of them, and their main constituent parts. At the same time, I will endeavour to indicate the principal deficiencies in our knowledge of these subjects, and may perhaps be able to add a few suggestions as to how some of these deficiencies might be best overcome.

In these remarks I will take the divisions of the earth's surface in the same order as I have generally used in my lectures on zoological geography, namely :

I.—Palæarctic Region	*Arctogæa.*
II.—Ethiopian Region	
II*a*.—Lemurian Sub-region	
III.—Indian Region	
IV.—Neartic Region	
V.—Neotropical Region	*Dendrogæa.*
V*a*.—Antillean Sub-region	
VI.—Australian Region . . .	*Antarctogæa.*
VII.—Pacific Region	*Ornithogæa.*

I.—THE PALÆARCTIC REGION.

The Palæarctic Region I shall consider for convenience sake in the following seven sub-regions :—

1. The *Cisatlantean Sub-region*, embracing all that part of the Palæarctic Region lying south of the Mediterranean Sea.

1*a*. The Atlantic Islands.

2. The *European Sub-region.*

3. The *Siberian Sub-region*, embracing the whole of Northern Asia.

4. The *Mantchurian Sub-region*, containing Northern China and the adjoining part of Mongolia.

5. The *Japanese Sub-region*, embracing the Japanese Islands.

6. The *Tartarian Sub-region*, containing the great desert-region of Central Asia.

7. The *Persian Sub-region*, embracing Persia, Asia Minor, and Syria.

1. THE CISATLANTEAN SUB-REGION.

As regards the zoology of the main western portion of this district (Tunis and Algeria) our knowledge may be now said to be pretty far advanced. The standard work on the subject is the "Exploration Scientifique de l'Algerie" published by the French Government, in which are treatises on the Mammals and Birds of Algeria by Loche, and on the Reptiles and Fishes by Guichenot. This work was commenced in parts in 1840, and the portions relating to the Mammals and Birds were, I believe, intended to have been written by M. Vaillant, the artist of the Commission ; but only the plates were issued, and the text by Captain Loche was not completed until 1867. A smaller and more convenient work for travellers is the last-named author's catalogue of the Mammals and Birds of Algeria, published in 1858.

As regards the herpetology of Algeria, an excellent memoir on this subject by Dr. Alexander Strauch will be found in the fourth volume of the new memoir of the Academy of St. Petersburg. Those who penetrate beyond the Atlas will find the lists of the vertebrated animals appended to Canon Tristram's "Great Sahara" very useful. Many interesting details about the birds of Tunis and Algeria will likewise be found in the papers communicated to the "Ibis," by Messrs. Salvin, Tristram, and J. H. Gurney, jun.

Of Morocco and the extreme western portion of the Atlas, our knowledge is as yet by no means so perfect. As regards the birds of Tangier and its vicinity, we have Colonel Irby's lately published volume on the Ornithology of the Straits of Gibraltar, in which the "observations on the Moorish birds are in a great measure culled from the MSS. of the late M. Favier—a collector long resident in Tangier." But in the south of Morocco, in the Western Atlas and surrounding district, there is certainly a considerable *terra incognita* within easy reach of England, which has hitherto been almost inaccessible to naturalists, though the short expedition of Dr. Hooker, Mr. Maw, and Mr. Ball in 1871 (of which a notice only has been published, but a complete scientific account is, I believe, in preparation), shows that it *may* be penetrated if proper precautions are taken.

1*a*. *The Atlantic Islands.*

The Atlantean island-groups of the Canaries, Madeira, and the Azores, may perhaps be most naturally appended to this division of the Palæarctic Region. Our knowledge of the fauna of each of these three groups is tolerable, although there is of course much to be done in working up details. As regards the Canaries, the standard work is Webb and Berthelot's "Histoire Naturelle des Iles Canaries," published at Paris under the auspices of the Minister of Public Instruction. Dr. Carl Bolle has visited the group more recently, and written several excellent articles in Cabanis's Journal on their ornithology.

Madeira has had the advantage of the residence of several first-class English naturalists—I need only mention the names of Lowe, Vernon, Wollaston, and Johnson, to establish this point. More than twenty years ago Mr. E. W. Harcourt, in his "Sketch of Madeira," and in contributions to the "Proceedings of the Zoological Society," and "Annals of Natural History," gave us a good account of the ornithology of Madeira. Mr. F. Godman has recently published an excellent article on the Birds of Madeira and the Canaries in the "Ibis" for 1872, in which a complete *résumé* is given of the whole of our previous knowledge of this subject, together with the information obtained by the author himself during his expedition to these islands in 1871.

As regards the fishes of Madeira, they have formed a subject of study of several excellent ichthyologists. The Rev. R. T. Lowe made numerous communications to the Zoological Society of London upon them in the early days of the Society, and published in their "Transactions" a Synopsis of Madeiran Fishes, to which divers supplements were afterwards added. Subsequently Mr. J. Y. Johnson took up the subject and made numerous additions to Mr. Lowe's experiences, which were mostly published by the same Society. Dr. Günther has likewise contributed to our knowledge of Madeiran fishes, so that on the whole there is, perhaps, hardly any locality out of Europe with the ichthyology of which we have a better general acquaintance.

For our knowledge of the higher animals of the third island-groups above spoken of, that of the Azores, we are mainly indebted to the energy of Mr. F. D. Godman, who made a special expedition to those islands in 1865, with the object of studying their fauna. The results are embodied in his volume on the Azores, published by Van Voorst in 1870. Morelet's work on the Azores, previously published, is mainly devoted to the Land-shell. Mr. Godman is almost the only authority upon the Mammals, Birds, and other Vertebrates.

2. THE EUROPEAN SUB-REGION.

To discuss, or even to give the titles of, all the works that have been published on the Vertebrates of Europe would extend this address to far beyond its proper limits. I must content myself with a few words on the principal works which have appeared of late years—first, upon the Zoology of Europe generally, and secondly, upon the Faunas of its chief political divisions.

A. *Mammals of Europe.*

To begin with the Mammals, our standard authority upon the European members of this class is Blasius's "Naturgeschichte der Saugethiere Deutschlands und der angrenzenden Länder," and an excellent work it is. Unfortunately, however, it does not extend into Southern Europe, where alone many of the more interesting forms of European Mammal-life make their appearance. A work founded on Blasius's volume and embracing the additional species of Mammals to be met with in Spain, Italy, and Turkey is very desirable, and it is with great pleasure that I have been informed that an energetic member of this Association has already set some such undertaking before him. The only work of reference of this extent that I am at present acquainted with is Lord Clermont's useful "Guide to the Quadrupeds and Reptiles of Europe," published in 1859. As regards the constituent countries of the European Sub-region, there are but few recommendable works devoted to the illustration of their Mammal-faunas. In England we have Bell's "British Quadrupeds," belonging to Mr. Van Voorst's excellent series. This remained long out of print, until its recent re-issue in 1874 by the author, with the assistance of Mr. R. F. Tomes and Mr. Alston. For France, M. Gervais's "Zoologie et Paléontologie Française" enumerates both recent and fossil Mammals, though most regard is paid to the extinct fauna. As regards Spanish Mammals, almost the only authority I am acquainted with is Rosenhauer's "Thiere Andalusiens" which is, however, very defective, the author having devoted himself principally to the study of the Invertebrates. Captain Cork (afterwards Widdrington) was the original discoverer of several of the rarer Mammals of Spain; but the account of them in his "Sketches" is very meagre. A bare list of the Mammals of Portugal is given by Prof. Barboza de Bocage in the "Revue Zoologique" for 1863. Passing over to Italy, Bonaparte's "Fauna Italica" and Costa's "Fauna del Regno di Napoli" must be mentioned, though both are somewhat out of date. But the former work is still the only authority on certain of the rarer Italian species and local forms.

A recent summary of Italian Mammals has been given by Prof. Cornalia in "Italia;" but on the whole it must be allowed that a good work upon the Mammals of the Italian peninsula is still a desideratum. Of the Mammals of Switzerland, on the other hand, we have an excellent recent work by Dr. Fatio, forming the first volume of his "Faune des Vertébrées de la Suisse," in which special attention is devoted to the difficult groups of Rodents and Insectivores. No student of the European Mammal-fauna should omit to consult it.

Passing to Eastern Europe, we find our state of exact knowledge as to the Mammals very defective. As regards Greece, we may refer to the French "Expedition Scientifique en Morée," in which there is a memoir on the Mammals by Geoffroy St. Hilaire, and Erhard's "Fauna der Cycladeen," which gives some details on the Mammals of the Greek Archipelago. Of Turkey we find very little information, and there is certainly still much to be done as regards the smaller Mammals of this part of Europe. In Russia we have Ménétriés's "Catalogue of the Animals of the Caucasus," and P. Demidoff's "Voyage dans la Russie Méridionale," and perhaps other works in the language of the country, which I am not acquainted with. But there can be no doubt that it is in South-eastern Europe that our knowledge of the Mammal-fauna of this continent is exceedingly defective, and that much remains to be done in order to complete our acquaintance with this branch of European Zoology.

In Northern Europe, which we now turn to, the case is quite different. The highly cultivated and laborious naturalists of Scandinavia have for many years paid great attention to this as to every other part of their fauna. The first volume of Nilsson's "Scandinavian Fauna," published at Lund in 1874, has long been a standard book of reference on this branch of zoology. Much, however, has been done since that period; and in Prof. Lilljeborg's lately issued work on the Mammals of Sweden and Norway, we have an exhaustive account of the present state of our knowledge of this subject.

As regards the few Mammals of Spitzbergen, reference should be made to the second volume of Heuglin's "Reisen nach dem Nordpolarmeer," where that energetic naturalist has put together an account of the nineteen species of Mammals that penetrate so far north.

B. *Birds of Europe.*

(a.) *Europe generally.*—There can be no question, I suppose, that the attractive class of Birds has received much more attention than its sister-classes of Vertebrates in Europe as generally elsewhere. Of late years especially a considerable number of naturalists in almost every part of this continent have devoted their principal attention to ornithology. Two journals are devoted solely to this science—in which the larger number of articles treat of the birds of some portion or other of Europe. The mass of literature on the subject is large, and I must therefore be rather concise in my notices of the principal modern authorities that should be referred to by an inquirer on the subject of European Ornithology.

First, as to the avifauna of the whole continent, Temminck's "Manual"—long the acknowledged authority on this subject—was superseded in 1849 by the issue of Degland's "Ornithologie Européenne." The new edition of this work, issued by the author and Gerbe jointly in 1867, is perhaps now the most complete book of its kind. But it has great faults and imperfections, particularly as regards its indications of the distribution of the species. This branch of the subject had never been properly worked until the recent issue of Mr. Dresser's (formerly Sharpe and Dresser's) "Birds of Europe," which contains, so far as it has hitherto progressed, by far the most exhaustive account of the European birds yet attempted. Its large size and numerous illustrations, however, render it rather cumbersome as a manual; but a handbook based on it when completed, and containing a judicious abridgment of its information (which I hope Mr. Dresser will not fail to prepare), will, I am sure, form a most valuable work.

Fritsch's "Naturgeschichte der Vögel Europas," lately published at Prague, is a cheap and useful manual for those who understand German; while Gould's "Birds of Europe," though out of date, will be always referred to for its illustrations.

(b.) *Birds of Great Britain.*—For many years the standard book of reference on the ornithology of these islands has been Yarrell's "British Birds," and its several Supplements. The new edition of this work, commenced in June 1871 by Prof. Newton, is familiar, no doubt, to most of the members of Section D. As to its merits there can be no question; I think it is seldom indeed that a task is entrusted to one so thoroughly competent to perform it, or so careful in the execution of what he undertakes. But the slow progress of the work is appalling. After four years only one of the promised four volumes has been completed. As amongst the best of numerous local works on the birds of this country recently issued should also be mentioned Gray's "Birds of the West of Scotland," and Hancock's memoir on those of Northumberland and Durham. A very useful work of reference for ornithologists is also Mr. Harting's "Hand-book of British Birds," in which the exact dates and places of occurrence of all the rarer visitants are recorded. Those who love life-sized illustrations, and have full purses, will not fail to acquire (provided a copy is left) Mr. Gould's splendid work on the "Birds of Great Britain," now complete in five volumes. After this enumeration it will be almost needless to remark that Ornithology has no reason to complain of want of support in this country.

(c.) *Birds of France.*—In France less attention has been devoted to the native birds of late years; and besides the new edition of Degland's "Ornithologie Européenne" already spoken of, I have only to mention Bailly's "Ornithologie de la Savrie," and Jaubert and Barthélemy-Lapommeraye's "Richesse Ornithologique de la Midi de la France," in each of which will be found much information about the rarer birds of the districts respectively treated of.

(d.) *Birds of Spain and Portugal.*—Much attention has been paid to the avifauna of Southern Spain of late years, but rather by visitors from the north than by native naturalists. Lord Lilford and Mr. Howard Saunders have both given us some excellent articles in the "Ibis" on this subject, and have made a variety of interesting discoveries, amongst which are actually several new species,[*] or at all events well-marked local forms. Dr. A. E. Brehm, long resident at Madrid, has also devoted much attention to Spanish ornithology, and written a complete list of Spanish Birds, which should be consulted. To Colonel Irby's work on the Straits of Gibraltar I have already alluded; as regards the southern extremity of the peninsula he is our best and most recent authority. For information on the birds of Portugal we must again go to an English source—Mr. Alfred Charles Smith, "Narrative of his Spring Tour" being the best authority which I am acquainted with on this subject.

(e.) *Birds of Italy.*—Savi's "Ornithologia Toscana," published as long ago as 1827, was for long almost our only authority on Italian ornithology. Bonaparte's "Iconographia," already alluded to, gave some additional information as to rarer species. Salvadori's memoir on the birds, forming the second volume of the recently published "Fauna d'Italia," is the best and most recent authority on this subject, and contains an excellent "Bibliografia Ornithologica Italiana." A large illustrated work on the birds of Lombardy has been recently published at Milan by Bettoni. We must also call attention to the persevering way in which Mr. C. A. Wright has worked up the Avifauna of Malta, and to Mr. A. B. Brooke's recently published notes on the Ornithology of Sardinia.

(f.) *Birds of Turkey and Greece.*—Dr. Krüper, a well-known German naturalist, has been long resident in various parts of the Levant, and has contributed numerous articles upon the birds met with to various periodicals. These have been recently put together and edited by Dr. Hartlaub, and published as a number of Mommsen's "Griechische Jahrezeiten," which thus contains a summary of all our principal information on the birds of Greece and its islands. Before that our best authority on Grecian birds was Lindermayer's "Vögel Griechenlands." As regards European Turkey, Messrs. Elwes and Buckley have lately published a good paper in the "Ibis" on its birds; and MM. Alléon and Vian have written several articles in the "Revue Zoologique" on the ornithology of the neighbourhood of Constantinople. But there is certainly still much to be done as regards birds in this part of the continent, as likewise amongst the islands of the Greek Archipelago, many of which are almost unexplored by the naturalist.

(g.) *Birds of Southern Russia and the Caucasus.*—Though many notices of the birds of Southern Russia have appeared in the "Bulletin" of the Society of Nuturalists of Moscow, I am not aware of any complete account of them having been issued. Demidoff, in the third volume of his "Voyage dans la Russie Méridionale," gives a list of the birds of what he calls the

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[*] *Gecinus Sharpii*, P.Z S. 1872, p. 153, and *Calandrella bætica*, Dresser, "Birds of Europe," pt. 21.

"Faune Pontique," but his original observations are somewhat meagre. Eichwald's "Fauna Caspio-Caucasica" and Ménétriés's Catalogue of the Zoology of the Caucasus, should also be consulted, although both are rather out of date. An excellent zoologist, Hr. Gustav Radde, is now resident at Tiflis; but I do not think he has yet prepared any general account of the birds of the Caucasus, where there must be certainly much of interest, as is proved by the discovery of the remarkable Grouse, allied to our Black Grouse, which has just been described by M. Taczanowski.*

(h.) *Birds of Germany and Central Europe.* – Local lists of the birds of the various States of Central Europe, and their principal divisions, are very numerous; and there are also many manuals and memoirs on the same subject. But J. A. Naumann's excellent "Vögel Deutschlands," commenced in 1822, with its supplements, is still, I believe, quite unsuperseded as a standard book of reference on Central European Ornithology. It was generally understood that Prof. Blasius, at the time of his lamented death, had a work on the birds of his native country in preparation; but unfortunately this was never finished, or it would have proved to be, no doubt, of first-rate excellence. In no other country, however, except our own, is ornithology so much cultivated as in Germany. Two societies emulate each other in their pursuit of this science, and a special journal is devoted to its progress. There is no lack, therefore, of recent information upon the birds of every part of Germany, although this has to be fished out of journals and periodicals of different sorts, instead of being put together, as we should rather wish to see it, in some general work.

(i.) *Birds of Scandinavia and North Europe.*—In Scandinavia also there is no dearth of diligent observers of birds as of every other class of animals. The bird-volume of Nilsson's Scandinavian Fauna was published in 1858, and is still worthy of careful study. But the more recent works of Collett upon the Birds of Norway, in German and in English, should be consulted, as also Sundevall's "Svenska Foglarna," unfortunately not quite finished at the time of his decease, and Von Wright and Palmén's "Finland's Foglar." Many memoirs have also recently appeared upon the birds of the extreme north, which have always attracted great interest among ornithologists. Amongst these special attention may be called to v. Heuglin's account of the birds of Nova Zembla, first published in Cabanis's Journal for 1872, and afterwards enlarged and revised in the second volume of his "Reisen in dem Nordpolarmeer;" to Prof. Newton's essay on the birds of Iceland in Mr. Baring-Gould's "Iceland, its Scenes and Sagas;" and lastly, to Messrs. Alston and Brown's narrative of their adventures among the birds of Archangel—a little explored district, and one of much promise, to which one of these active explorers has returned this year.

C. *European Herpetology.*

In this field of research there is not so much of recent work to record as among the birds; but Dr. E. Schrieber's "Herpetologia Europæa," which has just appeared, marks an important epoch in this branch of science, since there was previously no good work of reference upon the Reptiles and Batrachians of Europe. Dr. Schrieber's work is drawn up upon the same plan as Blasius's well-known "Säugethiere Europas," and forms a most convenient handbook. The list of published works and memoirs on the same subject prefaced to it renders it unnecessary for me to refer to the previous authorities on European herpetology in detail. I observe, however, that Lord Clermont's very useful "Guide to the Quadrupeds and Reptiles of Europe" is not referred to in the list, and it would appear that Dr. Schrieber is not acquainted with it. I must also call special attention to Dr. Strauch's excellent memoir on the Serpents of the Russian Empire, recently published in the Memoirs of the Imperial Academy of St. Petersburg, which is as important for the European as for the Asiatic part of the Russian dominion. As regards our native Herpetological Fauna also, I may point out that the last edition of Bell's "British Reptiles," published in 1839, requires considerable revision to bring it up to our present standard of knowledge, and that it is much to be desired that a new edition should be undertaken. Let me venture to suggest that Mr. Van Voorst should communicate with Dr. Günther upon this subject.

D. *European Ichthyology.*

I am not aware of the existence of any special work on European Ichthyology, but C. Th. v. Siebold published in 1863 a volume on the Fresh-water Fishes of Central Europe, which forms a useful guide to the Pisci-fauna of the principal European river-basins. For the fishes of the Atlantic which visit the British coasts we have the third edition of Yarrell's "British Fishes," edited by the late Sir John Richardson, which was published in 1859. Now that Dr. Günther's great general work on Fishes has been completed, this portion of Mr. Van Voorst's excellent series would be also much benefited by revision and rearrangement according to Dr. Günther's modern system and nomenclature. As a cheaper and more popular work we may also refer to Conch's "British Fishes" in four volumes, in which the figures are coloured.

Prof. Blanchard issued in 1866 a volume of the Freshwater Fishes of France, which, however, does not bear so high a character as Siebold's work above referred to. For our knowledge of the fishes of Spain and Portugal we are chiefly indebted to Steindachner's memoirs in the Sitzungsberichte of the Vienna Academy, and to F. de Brito Capello's papers in the *Journal of Sciences of Lisbon.* Of those of Italy, Prof. Canestrini has lately published a revised list with short specific characters, as a portion of the work called "Italia" already referred to. Those interested in the fishes of the Black Sea and adjoining river-basins should consult the ichthyological portion of Demidoff's "Voyage dans la Russie Méridionale," entitled "Pisces Faunæ Ponticæ." I am not acquainted with any other important recent memoirs on the ichthyological faunas of the different European States which it is necessary to refer to until we come to Scandinavia, where Malmgren published in 1863 an excellent essay upon the Fishes of Finland, which was subsequently translated into German. As regards the fishes of Spitzbergen and Nova Zembla, Heuglin's Synopsis of them in the second volume of his already quoted "Reisen nach dem Nordpolarmeer" is the most recent authority, though it is principally founded upon the labours of Lovén and Thorell, and of the naturalists of the Swedish expeditions of 1861 and 1864.

3. The Siberian Sub-region.

When I call to mind the numerous scientific expeditions sent by the Russians into different parts of their recent acquisition in Northern Asia, and turn over the pages of the excellent and instructive work in which the results of these expeditions have been given to the world, I must own to a feeling of indignation at the manner in which such matters are usually dealt with by the Government of this country. In the first place, in order to get such an expedition sent out at all, great exertions and special influence is necessary. The Treasury must be memorialised, the Chancellor of the Exchequer besought, and the Admiralty petitioned, before any grant of money can be sanctioned for the purpose, and even then it is too often bestowed in a niggardly and grudging way. When the expedition returns, similar applications have to be made in order to get the results worked out and properly published, and these are in some cases altogether rejected, so that the money already spent upon collecting becomes virtually thrown away. In Russia, although the nation may be less awake to the claims of science than in this country, the Government is certainly more so; and it is to the scientific men attached to the Government expeditions that we are indebted for nearly all the knowledge we possess of the fauna of Northern Asia. Of the more important reports of the more recent of these expeditions I will say a few words.

Middendorff's "Sibirische Reise," published in 1851, gives an account of the fauna of the extreme north and east of Siberia. The second volume of the zoological portion is entirely devoted to the Mammals, Birds, and Reptiles, and gives full details concerning the structure and habits of the species met with. Of Von Schrenck's "Amur-reise," a volume published in 1859, contains a complete memoir on the Mammals and Birds of the newly acquired district traversed by the Amoor, lying to the south of that investigated by Hr. v. Middendorff. Lastly, two volumes of Radde's "Reisen in dem Suden v. Ost-Sibirien," published in 1862 and 1863, render more perfect our knowledge of the Mammals and Birds of South-eastern Siberia. Hr. Radde's chief observations were made in Transbaikalia, but he incorporates the knowledge accumulated by his predecessors in the surrounding districts, and goes deeply into general results.

Dr. A. v. Middendorff's "Isepiptesen Russlands" should also be consulted by those who wish to understand the migration of birds in Siberia, or indeed throughout the Russian dominions.

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* *Tetrao mlokosiewiczi*, Tacz., P.Z.S., 1875.

4. THE MANTCHURIAN SUB-REGION.

Of this district, which embraces the country lying south of the Amoor and the greater part of Northern China, down perhaps to the great river Yang-tze, we have, besides the Russian works lastly spoken of, two principal sources of information. The first of these consists in the researches of Mr. Robert Swinhoe, of H.M. Chinese Consular Service, one of the most industrious and successful exploring naturalists that have ever lived, as is well known to many of my brother members here present. Mr. Swinhoe's memoirs and papers on Chinese Zoology are very numerous, but his last revised list of the birds of China will be found in the Zoological Society's "Proceedings" for 1871. Père Armand David, a worthy rival of our Consul, has likewise contributed in no small degree to our knowledge of the fauna of Northern China. His journals, containing numerous remarks full of interest, have lately been published in the "Nouvelle Archives du Muséum d'Histoire Naturelle de Paris;" and M. Alphonse Milne-Edwards's recently completed "Recherches sur les Mammifères" contains a section specially devoted to the Mammals of Northern China, which is mainly based on Père David's researches. I shall, however, have again occasion to mention the discoveries of both Mr. Swinhoe and M. David in a subsequent portion of this address.

5. THE JAPANESE SUB-REGION.

Temminck and Schlegel's "Fauna Japonica" have long been our standard authority upon the zoology of Japan, and not much has been done of late years to perfect it, except as regards the birds. On this branch of our subject some very good articles have been published in the "Ibis" by Capt. Blakiston, based upon his researches in Hakodadi; by Mr. Whitely, who was for some time resident along with Capt. Blackiston at the same port; and by Mr. Swinhoe. Reference should also be made to the second volume of Commodore Perry's "Narrative of the U.S. Expedition to Japan in 1852-54," wherein will be found articles on the birds collected by Cassin, and on the fishes by Brevoort.

6. THE TARTARIAN SUB-REGION.

Into the great desert-region of Central Asia, hitherto almost unknown, except from Eversmann's "Reise nach Buchara," which contains a short natural-history appendix, excursions have recently been made from two opposite quarters. The advancing tide of Russian conquest from the north, accompanied, as usual, by its scientific corps, has already made us well acquainted with the zoology of Turkestan. Mr. Severtzoff has unfortunately yielded to the unphilosophical spirit of nationality, which has of late years attained such a monstrous development, and published his "Turkestanskie Jevotnie," or review of the distribution of animal life in Turkestan, in his native Russian. But a translation and reproduction of the portion relating to the birds has already appeared in German, and an abstract of it in English is now being given to the world by Mr. Dresser in the "Ibis."

From the south, the peaceful embassies of this country to Yarkand have led naturalists into the fringe of the same zoological district. Of the first of these expeditions we have an excellent account as regards the birds by Mr. A. O. Hume, forming the second part of Henderson's "Lahore to Yarkand." Sir D. Forsyth's second expedition to Yarkand and Kashgar was accompanied by Dr. Ferdinand Stolitzska, one of the most accomplished and energetic members of the staff of the Indian Geological Survey, whose life was miserably sacrificed to the hardships encountered on the return. Of this last expedition we have as yet only incomplete accounts,* but may, I trust, look forward to the publication of an equally interesting volume on the zoological results. The ichthyological part of the collections has, I believe, been entrusted to Dr. F. Day to work out in this country.

7. THE PERSIAN SUB-REGION.

Of the Persian or "Mediterraneo-persic" Sub-region, as Mr. Elwes prefers to call it,† which may be held to embrace European Turkey, Palestine, and Persia, our knowledge was until recently very limited, and even up to the present day remains very imperfect, considering the proximity of the district to Europe, and the many interesting features which it presents. As regards Palestine, Canon Tristram's energetic researches have done much to remove what has long been a scandal to biblical scholars as well as to naturalists. His long-promised "Synopsis of the Flora and Fauna of Palestine" is, however, not yet issued by the Ray Society, and we must be consequently content with Mr. Tristram's papers on the Birds of the Holy Land in the "Ibis" and Dr. Günther's article upon the Reptiles and Fishes in the Zoological Society's "Proceedings," until the finished work appears. Of Asia Minor and Armenia it may be said that we are miserably ignorant, Tchihatcheff's desultory account of its natural history in his "Asie Mineure" being almost the only authority we have to refer to. Thirty years ago the Zoological Society had two excellent correspondents at Erzeroum —Messrs. Dickson and Ross; and it is a great misfortune that no continuous account was ever prepared of the fine collection which they sent home.*

As regards Persia, we may hope very shortly to be much more favourably situated. Mr. W. T. Blanford and Major St. John have recently made large zoological collections in various parts of that country, particularly of birds, and it is generally understood that the report of the Persian Boundary Expedition will contain a complete account of the zoology of Persia from Mr. Blanford's accomplished pen. Hitherto we have had to rely on De Filippi's "Viaggio in Persie," and other fragmentary sources of information.

II.—ÆTHIOPIAN REGION.

This region I shall speak of, for convenience sake, under the following six sub-divisions:—

1. *Western Africa*, from the Senegal to the Congo.
2. *South-western Africa*, or Angola and Benguela.
3. *South Africa.*
4. *South-eastern Africa*, from the Portuguese possessions up to the Somali coast.
5. *North-eastern Africa*, including Abyssinia, Nubia, and Egypt.
6. *Arabia.*

1. WESTERN AFRICA.

The Mammals of Western Africa are certainly not so well known as they should be; and there is no one work which gives an account of them except Temminck's "Esquisses Zoologiques sur la côte de Guinée," which is devoted to the collections transmitted to Leyden by Pel, a most energetic and successful Dutch explorer. On the Mammals of Gaboon, Pucheran's article in the French "Archives du Muséum," and Du Chaillu's travels and the literature connected therewith, should be consulted.

The birds of Western Africa, on the contrary, have attracted much attention from European naturalists since the time when Swainson published his "Birds of West Africa." This work, however, has been quite superseded by Hartlaub's classical "System der Ornithologique West-Afrikas," published in 1857. Since that period many memoirs and papers have appeared on the birds of various parts of this district, principally by Cassin, of Philadelphia, Dr. Finsch, of Bremen, and Mr. R. B. Sharpe, of the British Museum, who has paid special attention to the African Ornis, and is understood to be preparing a general work on the subject.

For information on the Reptiles and Fishes of West Africa we must refer to Aug. Duméril's memoir in the tenth volume of the "Archives du Muséum et Histoire Naturelle," founded on the collections in the Paris Museum.

2. SOUTH-WESTERN AFRICA.

The Portuguese colonies of Angola and Benguela, which seem to belong to a zoological sub-region, distinct from both that of West Africa and that of the Cape, were until recently almost unexplored. Within these last few years, however, Prof. Barboza du Bocage has acquired extensive series of specimens in nearly every department of natural history from these countries for the Lisbon Museum, and has published several important memoirs on the subject, which he will probably ultimately incorporate into a general work. Mr. J. J. Monteiro has also sent to this country collections of Mammals and Birds which have formed the subject of several papers in the Zoological Society's "Proceedings."

3. SOUTHERN AFRICA.

Sir Andrew Smith's "Illustrations of the Zoology of South Africa" constitute four solid octavo volumes, devoted to the new and rare vertebrates met with during that energetic traveller's many explorations of the Cape Colony and the adjoining districts. But there is no perfect list of the Cape fauna given in Sir Andrew Smith's work, and Mr. Layard's "Birds of South Africa," though not very completely elaborated, was, therefore, a most acceptable and convenient work to the ornithologist. Still more agreeable will it be to witness the completion of the new and enlarged edition of Mr. Layard's little volume, which Mr. Sharpe has undertaken, and of which he has just issued the first part. Mr. Sharpe will however, I trust, pardon me for remarking that he has cut the synonymy of the species rather short in his pages. It is hard to expect every South-African colonist to have at his side the British Museum Catalogue of Birds, to which he always refers us. Another modern and much-to-be-recommended bird-book belonging to this sub-region is Mr. J. H. Gurney's "Birds of Damara-land" founded on the extensive collection of the late C. J. Anderson. No less than 428 species of birds were obtained by this indefatigable collector, and the task of editing his field-notes has been well performed by Mr. Gurney.

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* See Hume, "Stray Feathers," ii. p. 513 and iii. p. 215.

† *Cf.* P.Z S. 1873, p. 647.

* See notices, P.Z.S. 1839, 1842, and 1844.

4. SOUTH-EASTERN AFRICA.

Our knowledge of the fauna of Mozambique is chiefly due to the scientific visit made to that country by Dr. W. Peters, of Berlin, in 1842 and the following years. The volume of this distinguished naturalist, "Naturwissenschaftliche Reise nach Mozambique," on the Mammals was published in 1852, that on the Fishes in 1864. The delay in the issue of the portions relating to the Reptiles and Birds is much to be regretted, more especially when we consider the high standard of the work, although diagnoses of the new species discovered in these groups have been long since published; and I am sure I am expressing the sentiments of naturalists in general when I say that I hope to see the series shortly completed. Proceeding further north along the African coast, we come to Zanzibar, where an excellent ichthyologist, Consul Playfair, was lately resident. The "Fishes of Zanzibar," by Günther and Playfair, founded on the extensive collections here made, was published in 1866, and gives an account of above 500 species, and many excellent figures.

The ornithology of the whole East-African coast, from Cape Gardafin to Mozambique, has been elaborately worked out by Drs. Finsch and Hartlaub. The results are contained in these authors' "Vogel Ost-Afrikans," forming the fourth volume of the unfortunate Baron Carl Claus von der Decken's "Reisen in Ost-Afrika." Full details as to older authorities on the subject are given in this excellent work, so that it is not necessary to refer to them.

As regards the Mammals of this part of Africa, however, it is necessary to say a few words. Our knowledge of this class of animals is, as regards the coast opposite Zanzibar and the country surrounding the great lakes of the interior, mainly comprised in the fragmentary collections of Speke and Grant (of which an account has been published in the Zoological Society's "Proceedings," and in the few specimens transmitted by Dr. Kirk from Zanzibar. There is no doubt, however, that much remains to be done here, and I believe there is at the present moment no finer field for zoological discovery available than this district, where we know that animal life in every variety is still abundant, and excellent sport can be obtained to add a zest to scientific investigation. The fishes of the great lake of Tanganyika and the Victoria and Albert Nyanza are likewise utterly unknown, and their investigation would be a subject of the greatest interest. Of those of the more southern Nyassa Lake, a few specimens have been obtained by Dr. Kirk.

5. NORTH-EAST AFRICA.

For many years Rüppell's "Atlas" and "Neue Wirbelthiere," and, as regards birds, his "Systematische Uebersicht," remained our standard works of reference upon the zoology of North-eastern Africa. The recent completion of Th. von Heuglin's "Ornithologie Nordost-Afrikas" has superseded Rüppell's volumes for general use; and no more valuable piece of work for ornithologists has been accomplished of late years than the reduction of the multitudinous observations and records of this well-known traveller and naturalist into a uniform series. V. Heuglin's work, however, concerns mainly Upper Nubia, Abyssinia, and the wide territory drained by the confluents of the Upper Nile. For Egypt and the Lower Nile a more handy volume is Capt. Shelley's "Birds of Egypt," published in 1872, which will be found specially acceptable to the tourist on the Nile. Nor must I forget to mention Mr. Blanford's interesting volume on the Geology and Zoology of Abyssinia, which contains an account of the specimens of Vertebrates collected and observed during his companionship with the Abyssinian Expedition. Mr. Jesse's birds, collected on the same occasion, were examined by Dr. Finsch, and the result given to the world in a memoir published in the Zoological Society's "Transactions."

A good revision of the Mammal-fauna of North-east Africa is much to be desired. Meanwhile Fitzinger's list of v. Heuglin's collection, and the latter author's own account of them in his Travels on the White Nile may be consulted.

6. ARABIA.

Of Arabia, as might have been expected, we know but little, zoologically or otherwise. But little, it may be said, can be expected to be found there, looking to the general aspect of the country. Still it would be of interest to know what that little is. At present the only district that has been visited by naturalists is the peninsula of Sinai, and of this our knowledge is by no means complete. Hemprich and Ehrenberg's unfinished "Symbolæ Physicæ" was for many years our sole authority. More recently Mr. Wyatt has published an article in the "Ibis" upon the birds of the Sinaitic peninsula. Let me suggest to some of the officers who are stationed idle at Aden that an account of the animals to be met with in that part of Arabia would be of great value, and would give them much useful and interesting occupation. I have been more than once told that there is nothing whatever to be found there. But this I am slow to believe. Anyone with a good pair of eyes and a taste for collecting might certainly do much good to science by passing a few months at Aden, and making excursions into that part of "Arabia Felix."

II*a*.—LEMURIAN SUB-REGION.

This aberrant appendage of the Ethiopian Fauna I will speak of under two heads, namely:—

1. *Madagascar.*
2. *Mascarene Islands.*

1. MADAGASCAR.

To our knowledge of the extraordinary fauna of "Lemuria," as I have elsewhere proposed to call Madagascar and its islands,[*] great additions have been recently made, but it is manifest that Madagascar is by no means yet worked out.[†] Dr. Hartlaub's "Ornithologischer Beitrag zur Fauna Madagascars" was the first attempt at a *résumé* of the remarkable avifauna of this part of the world. Since its issue two Dutch naturalists, Pollen and Van Dam, have visited Madagascar, and forwarded rich collections to the Leyden Museum. Of these the Mammals and Birds have been worked out by Professor Schlegel and Mr. Pollen, and the results published in a well-illustrated volume entitled "Recherches sur la Faune de Madagascar." This has been since followed by an accompanying account of the Fishes, and treatise on the Fisheries, by Messrs. Bleeker and Pollen. Following upon the footsteps of these naturalists, a French explorer, Alfred Grandidier, has since visited the interior of Madagascar, and in his turn has reaped a grand harvest, of which some of the results have already been given to the public. But we are promised to have these discoveries in a much more extended and complete form, in a work now in progress, in which M. Grandidier has obtained the efficient assistance of M. Alphonse Milne-Edwards. There still remain to be spoken of the discoveries recently made by an English collector in Madagascar, Mr. A. Crossley. Mr. Crossley's birds have been worked out by Mr. Sharpe in several papers published from time to time by the Zoological Society, while Dr. Günther has described several new and remarkable Mammals from the same source.

2. THE MASCARENE ISLANDS.

The fauna of the islands of Bourbon, Mauritius, and Rodriguez forms an appendage to that of Madagascar, and merits careful study. Our knowledge of these islands, since the recent investigation of Rodriguez by the naturalists sent out with the Venus Expedition, is tolerably complete, but requires to be put together, as it consists of fragments dispersed over various journals and periodicals. I trust that Mr. Edward Newton, who has had so many opportunities of acquiring information on this subject during his Colonial Secretaryship at Mauritius, and has so well used these opportunities, may shortly have leisure to devote to this task. His labours to recover the skeleton of *Pezophaps*, in which, I am pleased to think, he was aided by a grant from this Association, are well known, as is likewise the excellent memoir by himself and Prof. Newton, in which the result of his labours was given to the world. Nor must I omit to mention Prof. Owen's dissertations on the extinct fellow-bird of Mauritius, recently published by the Zoological Society.

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[*] Quart. Journ. of Science, 1864, p. 213.

[†] Witness the Mammal-forms, *Brachytarsomys* and *Mixocebus*, lately described by Dr. Günther and Dr. Peters, and the new genus of birds, *Neodrepanis*, recently characterised by Mr. Sharpe.

As regards the recent ornithology of these islands, we have nothing later to refer to than Hartlaub's little work on Madagascar, noticed above, which includes what was then known of the avifauna of the Mascarenes.

The neighbouring group of the Seychelles was visited by Mr. Edward Newton in 1867, and several new and most interesting species of birds obtained there. A complete account of the ornithology of these islands was given by Mr. Newton in the "Ibis" for 1867. Since that period Dr. E. P. Wright, formerly an active member of this Association, has made a scientific excursion to the Seychelles, with a view, as was generally understood, of preparing a complete monograph of the fauna and flora of these interesting islands. It is much to be regretted that this very desirable plan has not yet been accomplished.

III.—INDIAN REGION.

Of the extensive and varied Indian Region I will now proceed to say something under the subjoined heads :—

1. *British India.*
2. *Central* and *Southern China.*
3. *Burmah, Siam,* and *Cochin.*
4. *Malay Peninsula.*
4*a*. *Andaman* and *Nicobar Islands.*
5. *East-Indian Islands.*
6. *Philippine Archipelago.*

1. British India.

For British India Dr. Jerdon's well-known series of zoological handbooks was intended to supply a long-standing want ; and it is a great misfortune that his untimely death has interfered with their completion. The three volumes on Birds were finished in 1866, and one on Mammals in 1867. Of the volume on the Reptiles and Batrachians a portion, I believe, was actually in type at the time of his decease ; but of the Fishes no part, as far as I know, was so much advanced. For the Reptiles, therefore, we must for the present refer to Dr. Günther's "Reptiles of British India," published by the Ray Society in 1864. Indeed, as regards India, any future account of these animals must, in any case, be founded upon the basis of that excellent and conscientious work. For the Indian fishes generally there is at present no one authority, though Dr. Day, author of the "Fishes of Malabar" and of numerous other papers, is understood to have in preparation a general work on this subject, which his office of Inspector-General of Indian Fisheries has given him excellent opportunities of studying. Complete lists of both the freshwater and marine species of India are given in the appendices to Dr. Day's two "Reports on the Fisheries of India and Burmah," published in India in 1873.

But although our wants as regards the Indian Vertebrates will probably be supplied in this way, it would be much more satisfactory if the Indian Government would select a successor to Dr. Jerdon, and place under his control the necessary means for the preparation of a series of zoological handbooks for India. There is no reason why botany should be more favoured than zoology in this matter ; and I believe it is only the greater energy of the botanist that in this, as in other cases, has given them the start. New editions of Dr. Jerdon's Mammals and Birds are both necessary to bring our knowledge up to date, and the original editions are long out of print. There can be no question as to the great impetus to the study of natural history in India that has already followed on the publication of these handbooks ; and it will be a great misfortune to science if our Indian rulers fail to continue the good work. They have only to select a competent editor for the series, and to place the necessary funds temporarily at his disposal. The sale of the works would in the end recoup all the necessary expenses.

Amongst more recent contributions to our knowledge of Indian ornithology, which, under the influence above referred to, have been especially numerous, I can now only stop to call attention to a few. Mr. Allan Hume, C.B., has been specially active, and has published numerous papers in his queerly-titled periodical "Stray Feathers," which is exclusively devoted to Indian Ornithology. Amongst them the articles on the birds of Scinde and those of Upper Pegu are of special interest. Mr. Holdsworth's most useful "Synopsis of the Birds of Ceylon," lately published in the "Proceedings of the Zoological Society," is also of great value, more especially as Ceylon was omitted from the scope of Dr. Jerdon's work. Nor must I omit to mention Major Godwin-Austen's series of papers on the ornithology of the newly-explored districts on the north-eastern frontier, which contains so much of novelty and instruction.

As regards the Testudinata of India, we may shortly expect a complete account of them from Dr. John Anderson, who has devoted much time and toil to their study. His magnificent series of drawings of these animals, from living specimens, I have had the pleasure of inspecting ; and I trust sincerely that some means may be found of reproducing them for publication. Such a work would vastly increase our knowledge of this very difficult group of animals.

2. Central and Southern China.

In speaking of Northern China I have introduced the names of the two great modern zoological discoverers in China, Mr. Robert Swinhoe and M. le Père David. Mr. Swinhoe's article on the "Mammals of China," recently published in the Zoological Society's "Proceedings" gives a complete list of the species known to him to occur south of the Yang-tze. It includes those of the great island of Formosa, which is essentially part of China, although it possesses some endemic species, and which was a complete *terra incognita* to naturalists before Mr. Swinhoe's happy selection as the first British Vice-Consul in 1861. Mr. Swinhoe's last revised catalogue of the Birds of China, published in 1871, has been already referred to. He is now at home, unfortunately in ill health, but is by no means idle on his bed of sickness, and has in contemplation, and, I may say, in actual preparation, a complete work on Chinese Ornithology, for which he has secured the co-operation of one of our most competent naturalists.

The still more remarkable discoveries of Père David have revealed to us the existence on the western outskirts of China, or on the border-lands between China and Tibet, of a fauna hitherto quite unknown to us, and apparently a pendant of the Sub-Himalayan Hill-fauna first investigated by Hodgson. In his recently completed "Recherches sur les Mammifères," already referred to, M. Alphonse Milne-Edwards has given us a complete account of M. David's wonderful discoveries among the Mammals of this district. M. David's birds were worked out by the late Jules Verreaux, and the novelties described in the "Nouvelle Archives," but no complete list of them has yet been issued. In herpetology, I believe, M. David has also made some remarkable discoveries, amongst which, not the least assuredly, is the discovery of a second species of gigantic Salamander * in the mountain-streams of Moupin.

3. Burmah, Siam, and Cochin.

I speak of these ancient kingdoms, which occupy the main part of the great peninsula of South-eastern Asia, principally to express my surprise at how little we yet know of them. There are several good correspondents of the Jardin des Plantes in the French colony of Saigou, who have, I believe, transmitted a considerable number of specimens to the Muséum d'Histoire Naturelle, but beyond the descriptions of a certain number of novelties we have as yet received no account of them. The two philosophic Kings of Siam appear not yet to have turned their attention to biological discovery, although there is certainly much to be done in the interior of that State, with which the late M. Mouhot, had his life been spared, would certainly have made us better acquainted. As it happens we have only one or two published memoirs upon the results which this unfortunate naturalist achieved.

Lower Burmah now forms part of British India, and will be doubtless well explored. As regards Burmah proper and the Shan-States, our Indian legislators appointed a most efficient naturalist to accompany the Yucan Expedition of 1868 ; but when he returned, refused or neglected to provide him with the facilities to work out and publish his results. I rejoice, however, to learn that this error has been to a certain extent remedied, and that Dr. Anderson has now in preparation a connected account of his Yucan discoveries, which is to be issued by the Linnean Society in their "Transactions." A separate publication of these results would not have involved much additional expense, and would have been more worthy of the Government which sent out the expedition.

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* *Sieboldia Davidiana*, Blanchard.

4. MALAY PENINSULA.

The Malay peninsula belongs unquestionably to the same Sub-fauna as Sumatra. Its zoology is tolerably well known to us from numerous collections that have reached this country, but a modern revision of all the classes of Vertebrates is much to be desired. About twenty years ago, Dr. Cantor, of the East Indian Medical Service, published catalogues of the Mammals, Reptiles, and Fishes of Malacca in the Journal of the Asiatic Society of Bengal. To obtain a knowledge of its birds we must refer to the papers of Eyton, Wallace, and various other ornithological writers.

4*a*. ANDAMAN AND NICOBAR ISLANDS.

The two groups of islands in the Bay of Bengal have of late years attracted considerable attention from naturalists. Port Blair, in the Andaman Islands, having become the seat of an Indian penal settlement, has received visits from several excellent Indian workers who have made extensive collections, especially in ornithology. The most recent authorities upon the birds of the Andaman Islands are Lord Walden, who has worked out the series forwarded to him by Lieut. Wardlaw Ramsay, and Mr. Vincent Ball, who has published in "Stray Feathers" a complete list of all the birds known to occur in the Andaman and Nicobar groups.

5. EAST INDIAN ISLANDS.

Up to a recent period the standard authority on the fauna of the East Indian Islands was the great Dutch work on the Zoology of the foreign possessions of the Netherlands Government, based upon the vast collections formed by Macklot, Müller, and other naturalists, and transmitted to the Leyden Museum. This has been supplemented of late years by several works and memoirs of Dr. Schlegel, the eminent director of that establishment, and in particular by his "Musée des Pays Bas," which contains an account of that magnificent collection drawn up in a series of monographic catalogues. Up to this time, however, Dr. Schlegel has only treated of the class of birds, though at the present moment, I believe, he is engaged on a revision of Quadrumana. To the class of fishes, and especially to the fishes of the Dutch Islands and Seas in the East Indies, another naturalist, Dr. P. P. Bleeker, has for many years devoted great attention. His memoirs and papers on the Ichthyology and Herpetology of the various islands and settlements are far too numerous to mention. But his "Atlas Ichthyologique," his principal work on the Fishes of the Indian Seas, is one of great importance, and claims a special record as embracing the results of the life-work of one of the most energetic and laborious of living naturalists.

The travels of our countryman, Mr. Wallace, in the Malay Archipelago are well known to the general public from his instructive and entertaining narrative, and to zoologists from the large collections which he made in every branch of natural history. It is a misfortune that no general account of them has ever been prepared. But special articles on the birds of the Sula group to the east of Celebes or those of Bourou, and on those of the islands of Timor, Flores, and Lombock, will be found in the Zoological Society's "Proceedings," besides other ornithological papers referring more or less to this district.

Of the island of Celebes we have acquired more intimate knowledge from the researches of Dr. A. B. Meyer, and from two excellent memoirs on its Ornithology, prepared by Lord Walden. The adjacent territory of Borneo has likewise not escaped the attention of recent writers, an accomplished Italian author, Dr. Salvadori, having made it the subject of a special ornithological essay. For the animals of Java and Sumatra, we have unfortunately no such recent authority, but must refer primarily in the one case to Horsfield's Zoological Researches, and in the other to Sir Stamford Raffles' Catalogue, supplementing in each case the deficiency by reference to various more recent books and memoirs. The fact is that before we can attain precise notions as to the real zoological relations of these great islands, we require a much more complete acquaintance with their different faunas, and special monographic essays upon them. So there is certainly no lack of work remaining for the zoologist in this quarter.

6. PHILIPPINE ARCHIPELAGO.

In spite of the visits of Cuming, and more recently of Semper and Jagor, there has been until very lately great lack of a work for reference on the Vertebrates of the Philippine Archipelago. This deficiency has been partly supplied by the excellent essay published by Lord Walden in the "Transactions" of the Zoological Society, upon the Birds of the Philippines. Although based upon the collections of Dr. A. B. Meyer, this memoir contains a *résumé* of all that is yet known upon the subject. It likewise points out the deficencies in our present information, which, I need hardly add, are many and numerous.

That the knowledge of our Mammal-fauna of the Philippines is also by no means perfect, will be sufficiently manifest when I recall to my hearers the fact that there is now living in the Zoological Society's Gardens a very distinct species of Deer,[*] quite unknown to all our Museums, which is undoubtedly endemic in one of the Philippine Islands. There is much want of more information on this subject, as also on the Reptiles and Fishes, although Dr. Peters has lately made us acquainted with many novelties from Jagor's researches in these branches.

IV.—NEARCTIC REGION.

This part of my subject will be most conveniently treated of under two heads:—

1. *North America down to Mexico,*
2. *Greenland,*

leaving Mexico to be spoken of as a whole under the Neotropical Region, although part of it undoubtedly belongs to the Nearctic.

1. NORTH AMERICA.

(a.) *Mammals.*—The latest revision of the Mammals of North America is still that of Prof. Baird, contained in the Reports on the Zoology of the Pacific Railway Routes, published by the War Department of the U.S. in 1857. I understand, however, that Dr. Coues is now engaged on a more perfect work on the same subject, which will embrace the results of the large additions since made to our knowledge of this subject. The marine Mammals are not included in Prof. Baird's revision; and under this head I may notice two important works recently issued, Mr. Allen's memoir on the Eared Seals, which specially treats of the North-Pacific species, and Capt. Scammon's volume on the marine Mammals of the North-western coasts of North America, which contains a mass of information relative to the little-known Cetaceans of the North Pacific.

Prior to them Audubon and Bachman's Quadrupeds of North America, published at New York in 1852, was the best book of reference.

(b.) *Birds of North America.*—The American ornithologists have been specially active of late years. Up to about twenty years ago, the recognised authorities upon the Birds of the United States were Wilson, Audubon, Bonaparte, and Nuttall. In 1856 Cassin's "Illustrations," chiefly devoted to the species then recently discovered in Texas, California, and Oregon, appeared. In 1858 the joint work of Messrs. Baird, Cassin, and Lawrence, on the Birds of North America, forming part of the "Pacific Railway Routes," was issued. This was republished with additions as a separate work in 1860 in two volumes, and still forms an excellent work of reference on American ornithology. The List of Authorities given at the end of the letterpress will be found extremely useful for those who require a guide to the literature of American ornithology. But even this bids fair to be superseded by the more recent publications of our energetic fellow naturalists. In the first place, three volumes of a "History of North-American Birds," illustrated by plates and numerous woodcuts, by Messrs. Baird, Brewer, and Ridgway (were issued last year, and two more volumes to complete the work will soon be ready. Then for those who require a handy book for reference nothing can be more convenient than Dr. Coues' "Key," in one volume, published in 1872. The same energetic naturalist has also lately issued a "Handbook of the Ornithology of the North-west," containing an account of the birds met with in the region drained by the Missouri and its tributaries, amongst which he has had such long personal experience. Nor must I conclude the list without mentioning Mr. D. G. Elliot's "Birds of North America," which contains life-sized illustrations of many rare and previously unfigured species, and Cooper's "Birds of California," devoted to an account of the birds of the Pacific coast-region, which has been edited by Prof. Baird from the late Mr. Cooper's MSS. Of the last-named work, however, only the first volume is yet published. It will be thus seen that we have ample means of acquiring the most recent information on the birds of the Nearctic Region, and in fact in no part of the world, except Europe itself, is our knowledge of the endemic avifauna so nearly approaching towards completion.

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[*] *Cervus Alfredi*, Sclater, P.Z.S. 1870, p. 381, pl. xxviii.

(c.) *Reptiles and Batrachians of North America.*—Holbrook's "North American," in five quarto volumes, published at Philadelphia in 1843-4, contains coloured figures of all the North American Reptiles and Batrachians known to the author, and is a reliable work. A large amount of information has been acquired since that period and published in the various "Railway Reports" and periodicals by Hallowell, Baird, Cope, and others. In 1853 Messrs. Baird and Girard published a catalogue of North American Serpents, and Prof. Agassiz devoted the first volume of his "Contributions" mainly to the Testudinata of North America. Prof. Baird tells me that Prof. Cope is now engaged in printing a new catalogue of the Reptiles and Batrachians of North America, which will contain an enumeration of all the species and an account of their geographical distribution.

(d.) *Fishes of North America.*—Of the fishes of North America there is up to the present time no one authority, and the inquirer must refer to the various works of De Kay, Agassiz, and Girard for information. This, aided by the copious references in Dr. Günther's masterly Catalogue, he will have little difficulty in obtaining, so far as it is available. But the "History of American Fishes" is still to be written, and I have no doubt that our energetic brethren of the United States will before long bring it to pass.

2. GREENLAND.

Of Greenland, which is undoubtedly part of the Nearctic Region, I have made a separate section in order to call special attention to the "Manual" for the use of the Arctic Expedition of 1875, prepared under the direction of the Arctic Committee of the Royal Society. A *résumé* of all that is yet known of the biology of Greenland is included in this volume. I may call special attention to the article on the Birds by Prof. Newton, and on the Fishes by Dr. Lütken, both prepared specially for this work. I am sure you will all join with me in thanking the present Government for sending out this new expedition so fully prepared in every way, and in hoping that large additions may be made to the store of information already accumulated in the "Manual."

(*To be continued.*)

Department of Anthropology.

ADDRESS BY GEORGE ROLLESTON, M.D., F.R.S., F.S.A., PRESIDENT OF THE DEPARTMENT.

Dr. Rolleston began his address by referring to a few of the principal papers which were to be brought before the department. He referred in congratulatory terms to the work in the Pacific Islands brought out this year by Dr. Carl E. Meinicke, and to an article by the Rev. S. J. Whitmee in the *Contemporary Review* for February as the most important recent contribution to the ethnology of Polynesia. He then spoke in high terms of the services rendered to the native Polynesians by the missionaries, quoting to the same effect from Gerland's continuation of Wurtz's "Anthropologie." He also referred critically to Mr. Bagehot's statement that savages did not formerly waste away before the classical nations, as they do now before the modern civilised nations. He then went on to say:—

I come now to the consideration of the subject of craniology and craniography. Of the value of the entirety of the physical history of a race there is no question; but two very widely opposed views exist as to the value of skull-measuring to the ethnographer. According to the views of one school, craniography and ethnography are all but convertible terms; another set of teachers insist upon the great width of the limits within which normal human crania from one and the same race may oscillate, and upon the small value which, under such circumstances, we can attach to differences expressed in tenths of inches or even of centimetres. As usual, the truth will not be found to be in either extreme view. For the proper performance of a craniographic estimation, two very different processes are necessary: one is the carrying out and recording a number of measurements; the other is the artistic appreciation of the general impressions as to contour and type which the survey of a series of skulls produce upon one. I have often thought that the work of conducting an examination for a scholarship or fellowship is very similarly dependent, when it is properly carried out, upon the employment of two methods—one being the system of marking, the other that of getting a general impression as to the power of the several candidates; and I would wish to be understood to mean by this illustration not only that the two lines of inquiry are both dependent upon the combination and counterchecking of two different methods, but also that their results, like the results of some other human investigations, must not be always, even though they may be sometimes, considered to be free from all and any need for qualification. Persons like M. Broca and Prof. Aeby, who have carried out the most extensive series of measurements, are not the persons who express themselves in the strongest language as to craniography being the universal solvent in ethnography or anthropology. Aeby, for example, in his "Schädelformen der Menschen und der Affen," 1867, p. 61, says:—"Aus dem gesagten geht hervor dass die Stellung der Anthropologie gegenüber den Schädelformen eine ausserordentlich schwierige ist;" and the perpetual contradiction of the results of the skull-measurements carried out by others, which his paper (published in last year's "Archiv für Anthropologie," pp. 12, 14, 20) abounds in, furnishes a practical commentary upon the just quoted words. And Broca's words are especially worth quoting, from the "Bulletin de la Société d'Anthropologie de Paris," Nov. 6, 1873, p. 824:—"Dans l'état actuel de nos connaissances la craniologie ne peut avoir la pretention de voler de ses propres ailes, et de substituer ses diagnostics aux notions fournies par l'ethnologie et par l'archæologie."

I would venture to say that the way in which a person with the command of a considerable number of skulls procured from some one district in modern times, or from some one kind of tumulus or sepulchre in prehistoric times, would naturally address himself to the work of arranging them in a museum, furnishes us with a concrete illustration of the true limits of craniography. I say, "a person with the command of a considerable number of skulls;" for, valuable as a single skull may be, and often is, as furnishing the missing link in a gradational series, one or two skulls by themselves do not justify us (except in rare instances, which I will hereinafter specify) in predicating anything as to their nationality. Greater rashness has never been shown, even in a realm of science from which rashness has only recently been proceeded against under an Alien Act, than in certain speculations as to the immigration of races into various corners of the world, based upon the casual discovery in such places of single skulls, which skulls were identified on the ground of their individual characters as having belonged to races shown on no other evidence to have ever set foot there.

It is, of course, possible enough for a skilled craniographer to be right in referring even a single skull to some particular nationality; an Australian or an Eskimo, or an Andamanese might be so referred with some confidence; but all such successes should be recorded with the reservation suggested by the words, *ubi eorum qui perierunt?* and by the English line, "The many fail, the one succeeds." They are the shots which have hit and have been recorded. But if it is unsafe to base any ethnographic conclusions upon the examination of one or two skulls, it is not so when we can examine about ten times as many—ten, that is to say, or twenty, the locality and the dates of which are known as certain quantities. A craniographer thus fortunate casts his eye over the entire series, and selects from it one or more which correspond to one of the great types based by Retzius not merely upon consideration of proportionate lengths and breadths, but also upon the artistic considerations of type, curve, and contour. He measures the skulls thus selected, and so furnishes himself with a check which even the most practised eye cannot safely dispense with. He then proceeds to satisfy himself as to whether the entire series is referable to one alone of the two great typical forms of Brachycephaly or Dolichocephaly, or whether both types are represented in it, and if so, in what proportions and with what admixture of intermediate forms. With a number of Peruvian, or, indeed, of Western American skulls generally, of Australian, of Tasmanian, of Eskimo, of Veddah, of Andamanese crania before him, the craniographer would nearly always, setting aside a few abnormally aberrant (which are frequently morbid) specimens, refer them all to one single type.*

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* It is not by any means entirely correct to say that there is no variety observable among races living in isolated savage urity. The good people of

Matters would be very different when the craniographer came to deal with a mixed race like our own, or like the population of Switzerland, the investigation into the craniology of which has resulted in the production of the invaluable "Crania Helvetica" of His and Rütimeyer. At once, upon the first inspection of a series of crania, or, indeed, of heads, from such a race, it is evident some are referable to one, some to another, of one, two, or three typical forms, and that a residue remains whose existence and character is perhaps explained and expressed by calling them "Mischformen." Then arises a most interesting question —Has the result of intercrossing been such as to give a preponderance to these "Mischformen?" or has it not rather been such as in the ultimate resort, whilst still testified to by the presence of intermediating and interconnecting links, to have left the originally distinct forms still in something like their original independence, and in the possession of an overwhelmed numerical representation? The latter of these two alternative possibilities is certainly often to be seen realised within the limits of a modern so-called "English" or so-called "British" family; and His has laid this down as being the result of the investigations above mentioned into the ethnology of Switzerland. At the same time it is of cardinal importance to note that His has recorded, though only in a footnote, that the skulls which combine the characters of his two best-defined types, the "Sion-Typus" to wit, and the "Disentis-Typus," in the "Mischform," which he calls "Sion-Disentis Mischlinge," are the most capacious of the entire series of the "Crania Helvetica," exceeding, not by their maximum only, but by their average capacity also, the corresponding capacities of every one of the pure Swiss types.* Intercrossing, therefore, is an agency which in one set of cases may operate in the way of enhancing individual evolution, whilst in another it so divides its influence as to allow of the maintenance of two types in their distinctness. Both these results are of equal biological, the latter is of pre-eminent archæological, interest. Retzius† was of opinion, and with a few qualifications I think more recent Swedish ethnologists would agree, that the modern dolichocephalic Swedish cranium was very closely affined to, if not an exact reproduction of the Swedish cranium of the Stone period; and Virchow‡ holds that the modern brachycephalic Danish skull is similarly related to the Danish skull of the same period. There can be no doubt that the Swedish cranium is very closely similar indeed to the Anglo-Saxon; and the skulls which still conform to that type amongst us will be by most men supposed to be the legitimate representatives of the followers of Hengest and Horsa, just as the modern Swedes, whose country has been less subjected to disturbing agencies, must be held to be the lineal descendants of the original occupiers of their soil. I am inclined to think that the permanence of the brachycephalic stock and type in Denmark has also its bearing upon the ethnography of this country. In the Round-Barrow or Bronze period in this country, subspheroidal crania (that is to say, crania of a totally different shape and type from those which are found in exclusive possession of the older and longer barrows) are found in great abundance, sometimes, as in the south, in exclusive possession of the sepulchre, sometimes in company, as in the north, with skulls of the older type. The skulls are often strikingly like those of the same type from the Danish tumuli. On this coincidence I should not stake much, were it not confirmed by other indications. And foremost amongst these indications I should place the fact of the "Tree-interments," as they have been called—interments, that is, in coffins made out of the trunk of a tree of this country, and of Denmark, being so closely alike. The well-known monoxylic coffin from Gristhorpe contained, together with other relics closely similar to the relics found at Treenhoi, in South Jutland, in a similar coffin, a skull which, as I can testify from a cast given me by my friend Mr. H. S. Harland, might very well pass for that of a brachycephalic Dane of the Neolithic period. Canon Greenwell discovered a similar monoxylic coffin at Skipton, in Yorkshire; and two others have been recorded from the same county, one from the neighbourhood of Driffield, the other from that of Thornborough.

Col. Lane Fox is of opinion that the earthworks which form such striking objects for inquiry here and there on the East Riding Wolds must, considering that the art of war has been the same in its broad features in all ages, have been thrown up by an invading force advancing from the east coast. Now, we do know that England was not only made England by immigration from that corner or angle where the Cimbric Peninsula joins the main land, but that long after that change of her name this country was successfully invaded from that peninsula itself. And what Swegen and Cnut did some four hundred and fifty years after the time of Hengest and Horsa, it is not unreasonable to suppose other warriors and other tribes from the same locality may have done perhaps twice or thrice as many centuries further back in time than the Saxon Conquest. The huge proportions of the Cimbri, Teutones, and Ambrones, are just what the skeletons of the British Round-Barrow folk enable us now to reproduce for ourselves. It is much to be regretted that from the vast slaughters of Aquæ Sextiæ and Vercellæ no relics have been preserved which might have enabled us to say whether Boiorix and his companions had the cephalic proportions of Neolithic Danes, or those very different contours which we are familiar with from Saxon graves throughout England, and from the so-called "Danes' graves" of Yorkshire. Whatever might be the result of such a discovery and such a comparison, I think it would in neither event justify the application of the term "Kymric" to the particular form of skull to which Retzius and Broca have assigned it.

Some years ago I noticed the absence of the brachycephalic British type of skull from an extensive series of Romano-British skulls which had come into my hands; and subsequently to my doing this, Canon Greenwell pointed out to me that such skulls as we had from late Celtic cemeteries, belonging to the comparatively short period which elapsed between the end of the Bronze period and the establishment of Roman rule in Great Britain, seemed to have reverted mostly to the præ-Bronze dolichocephalic type. This latter type, the "kumbecephalic type" of Prof. Daniel Wilson, manifests a singular vitality, as the late and much lamented Prof. Phillips pointed out long ago at a meeting of this Association held at Swansea—the dark-haired variety, which is very ordinarily the longer-headed and the shorter-statured variety of our countrymen being represented in very great abundance in those regions of England which can be shown, by irrefragable and multifold evidence, to have been most thoroughly permeated, imbibed, and metamorphosed by the infusion of Saxons and Danes in the districts, to wit, of Derby, Leicester, Stamford, and Loughborough. How and in what way this type of man, one to which some of the most valuable men now bearing the name of Englishmen, which they once abhorred, belong, has contrived to reassert itself, we may, if I am rightly informed, hear some discussion in this department. Before leaving this part of my subject I would say that the Danish type of head still survives amongst us; but it is to my thinking not by any means so common, at least in the midland counties, as the dark-haired type of which we have just been speaking. And I would add that I hope I may find that the views which I have here hinted at will be found to be in accord with the extensive researches of Dr. Beddoe, a gentleman who worthily represents and upholds the interests of anthropology in this city, the city of Prichard, and who is considered to be more or less disqualified for occupying the post which I now hold, mainly from the fact that he has occupied it before, and that the rules of the British Association, like the laws of England, have more or less of an abhorrence of perpetuities.

The largest result which craniometry and cubage of skulls have attained is, to my thinking, the demonstration of the following facts, viz.:—first, that the cubical contents of many skulls from the earliest sepultures from which we have any skulls at all, are larger considerably than the average cubical contents of modern European skulls; and secondly, that the female skulls of those times did not contrast to that disadvantage with the skulls of their male contemporaries which the average female skulls of modern days do, when subjected to a similar comparison.* Dr. Thurnam demonstrated the former of these facts, as regards the skulls from the Long and the Round Barrows of

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Baden who, when they first saw them, said all the Baskhirs in a regiment brought up to the Rhine in 1813 by the Russians were as like to each other as twins, found, in the course of a few weeks, that they could distinguish them readily and sharply enough (Crania Germaniæ Occid. p. 2; Archiv fur Anthrop. v. p. 485, 1872). And real naturalists, such as Mr. Bates, practised in the discrimination of zoological differences, express themselves as struck rather with the amount of unlikeness than with that of likeness which prevails amongst savage tribes of the greatest simplicity of life and the most entire freedom from crossing with other races. But these observations relate to the *living heads*, not to the skulls.

* See Dr. Beddoe, Mem. Soc. Anth. Lond. iii. p. 552; Huth, p. 308, 1875; D. Wilson, cit. Brace, "Races of the Old World," p. 380.

† "Ethnologische Schriften," p. 7.

‡ "Archiv für Anthropologie," iv. pp. 71 and 80.

* The subequality of the male and female skulls in the less civilised of modern races was pointed out as long ago as 1845 by Retzius, in Müller's "Archiv," p. 89, and was commented upon by Huschke, of Jena, in his "Schädel, Hirn, und Seele," pp. 48–51, in 1854.

Wiltshire, in the Memoirs of the London Anthropological Society for 1865; and the names of Les Eyzies and Cro-Magnon, and of the Caverne de l'Homme Mort, to which we may add that of Solutré, remind us that the first of these facts has been confirmed, and the second both indicated and abundantly commented upon by M. Broca.

The impression which these facts make upon one, when one first comes to realise them, is closely similar to that which is made by the first realisation to the mind of the existence of a subtropical flora in Greenland in Miocene times. All our anticipations are precisely reversed, and in each case by a weight of demonstration equivalent to such a work; there is no possibility in either case of any mistake; and we acknowledge that all that we had expected is absent, and that where we had looked for poverty and pinching there we come upon luxurious and exuberant growth. The comparisons we draw in either case between the past and the present are not wholly to the advantage of the latter: still such are the facts. Philologists will thank me for reminding them of Mr. Chauncy Wright's brilliant suggestions that the large relative size of brain to body which distinguishes, and always, so far as we know, has distinguished the human species as compared with the species most nearly related to it, may be explained by the psychological tenet that the smallest proficiency in the faculty of language may "require more brain power than the greatest in any other direction," and that "we do not know and have no means of knowing what is the quantity of intellectual power as measured by brains which even the simplest use of language requires.[*]

And for the explanation of the pre-eminently large size of the brains of these particular representatives of our species, the tenants of prehistoric sepulchres, we have to bear in mind, first, that they were, as the smallness of their numbers and the largeness of the tumuli lodging them may be taken to prove, the chiefs of their tribes; and, secondly, that modern savages have been known, and prehistoric savages may therefore be supposed, to have occasionally elected their chiefs to their chieftainships upon grounds furnished by their superior fitness for such posts—that is to say, for their superior energy and ability. Some persons may find it difficult to believe this, though such facts are deposed to by most thoroughly trustworthy travellers, such as Baron Osten Sacken, referred to by Von Baer, in the Report of the famous Anthropological Congress at Göttingen, in 1861, p. 22. And they may object to accepting it, for, among other reasons, this reason—to wit, that Mr. Galton has shown us in his "Men of Science, their Nature and Nurture," p. 98, that men of great energy and activity (that is to say just the very men fitted to act as leaders of and to commend themselves to savages)[†] have ordinarily smaller-sized heads than men possessed of intellectual power dissociated from those qualities.

The objection I specify, as well as those which I allude to, may have too much weight assigned to them; but we can waive this discussion and put our feet on firm ground when we say that in all savage communities the chiefs have a larger share of food and other comforts, such as there are in savage life, and have consequently better and larger frames—or, as the Rev. S. Whitmee puts it (*l.c.*), when observing on the fact as noticed by him in Polynesia, a more "portly bearing." This (which, as the size of the brain increases within certain proportions with the increase of the size of the body, is a material fact in every sense) has been testified to by a multitude of other observers, and is, to my mind, one of the most distinctive marks of savagery as opposed to civilisation. It is only in times of civilisation that men of the puny stature of Ulysses or Agesilaus are allowed their proper place in the management of affairs. And men of such physical size, coupled with such mental calibre, may take comfort, if they need it, from the purely quantitative consideration, that large as are the individual skulls from prehistoric graves, and high, too, as is the average obtained from a number of them, it has nevertheless not been shown that the largest individual skulls of those days were larger than, or, indeed, as large as the best skulls of our own days; whilst the high average capacity which the former series shows is readily explicable by the very obvious consideration that the poorer specimens of humanity, if allowed to live at all in those days, were, at any rate, when dead not allowed sepulture in the "tombs of the kings," from which nearly exclusively we obtain our prehistoric crania. M. Broca[*] has given us yet further ground for retaining our self-complacency by showing, from his extensive series of measurements of the crania from successive epochs in Parisian burial-places, that the average capacity has gone on steadily increasing.

It may be suggested that a large brain, as calculated by the cubage of the skull, may nevertheless have been a comparatively lowly organised one, from having its molecular constitution qualitatively inferior from the neuroglia being developed to the disadvantage of the neurine, or from having its convolutions few and simple, and being thus poorer in the aggregate mass of its grey ossicular matter. It is perhaps impossible to dispose absolutely of either of these suggestions. But, as regards the first, it seems to me to be exceedingly improbable that such could have been the case. For in cases where an overgrowth of neuroglia has given the brain increase of bulk without giving it increase of its true nervous elements, the Scotch proverb, "Muckle brain, mickle wit," applies; and the relatively inferior intelligence of the owners of such brains as seen nowadays may, on the principle of continuity, be supposed to have attached to the owners of such brains in former times. But those times were times of a severer struggle for existence than even the present; and inferior intelligences, and specially the inferior quickness and readiness observable in such cases, it may well be supposed, would have fared worse then than now. There is, however, no need for this supposition, for, as a matter of fact, the braincase of brains so hypertrophied[†] has a very recognisable shape of its own, and this shape is not the shape of the Cro-Magnon skull, nor indeed of any of the prehistoric skulls with which I am acquainted.

As regards the second suggestion to the effect that a large braincase may have contained a brain the convolutions of which were simple, broad, and coarse, and which made up by consequence a sheet of grey matter of less square area than that made up in a brain of similar size, but of more complex and slenderer convolutions, I have to say that it is possible this may have been the case, but that it seems to me by no means likely. Very large skulls are sometimes found amongst collections purporting to have come from very savage or degraded races; such a skull may be seen in the London College of Surgeons with a label, "5357 D. Bushman, G. Williams. Presented by Sir John Lubbock;" and, from what Prof. Marshall and Gratiolet have taught us as to other Bushman brains, smaller, it is true, in size, we may be inclined to think that the brain which this large skull once contained may nevertheless have been much simpler in its convolutions than a European brain of similar size would be. This skull, however, is an isolated instance of such proportions amongst Bushman skulls, so far, at least, as I have been able to discover; whilst the skulls of prehistoric times, though not invariably, are yet most ordinarily large skulls. A large brain with coarse convolutions puts its possessor at a disadvantage in the struggle for existence, as its greater size is not compensated by greater dynamical activity; and hence I should be slow to explain the large size of ancient skulls by suggesting that they contained brains of this negative character. And I am glad to see that M. Broca is emphatically of this opinion, and that, after a judicious statement of the whole case, he expresses himself thus (*Revue d'Anthropologie*, ii. 1, 38):—"Rien ne permet donc de supposer que les rapports de la masse encéphalique avec l'intelligence fussent autres chez eux que chez nous."

It is by a reference to the greater severity of the struggle for existence and to the lesser degree to which the principle of division of labour was carried out in olden days, that M. Broca, in his paper on the "Caverne de l'Homme Mort," just quoted from, explains the fact of the subequality of the skulls in the two sexes. This is an adequate explanation of the facts; but to the facts as already stated, I can add from my own experience the fact that though the female skulls of prehistoric times are often they are not always equal, or nearly, to those of the male sex of those times; and, secondly, that whatever the relative size of the head, the limbs and trunk of the female portion of those tribes were, as is still the case with modern savages, very usually disproportionately smaller than those of the male. This is readily enough explicable by a reference to the operations of causes exemplifications of the working of which are unhappily not far to seek now, and may be found in any detail you please in those anthropologically interesting (however otherwise unpleasant) documents, the Police Reports.

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[*] The bibliographer will thank me also for pointing out to him that the important paper in the *North American Review* for October 1870, p. 295, from which I have just quoted, has actually escaped the wonderfully exhaustive research of Dr. Seidlitz (see his "Darwin'sche Theorie," 1875).

[†] An interesting and instructive story in illustration of the kind of qualis which do recommend a man to savages, is told us by Sir Bartle Frere his pamphlet, "Christianity suited to all forms of Civilisation," pp. 12-14.

[*] See his paper "Bull. Soc. Anthrop. de Paris," t. iii. ser. i. 1862, p. 102; or his collected "Mémoires," vol. i. p. 348, 1871.

[†] I may, perhaps, be allowed to express here my surprise at the statement made by Messrs Wilks and Moxon, in their very valuable "Pathological Anatomy," pp. 217, 218, to the effect that they have not met with such cases of cerebral hypertrophy. They were common enough at the Children's Hospital in Great Ormond Street when I was attached to it.

Having before my mind the liability we are all under fallaciously to content ourselves with recording the shots which hit, I must not omit to say that one at least of the more recently propounded doctrines in craniology does not seem to me to be firmly established. This is the doctrine of "occipital dolichocephaly" being a characteristic of the lower races of modern days and of prehistoric races as compared with modern civilised races. I have not been able to convince myself by my own measurements of the tenability of this position; and I observe that Ihering has expressed himself to the same effect, appending his measurements in proof of his statements in his paper, "Zur Reform der Craniometrie," published in the "Zeitschrift für Ethnologie" for 1873. The careful and colossal measurements of Aeby [*] and Weisbach [†] have shown that the occipital region enjoys wider limits of oscillation than either of the other divisions of the cranial vault. I have some regret in saying this, partly because writers on such subjects as "Literature and Dogma" have already made use of the phrase "occipitally dolichocephalic," as if it represented one of the permanent acquisitions of science; and I say it with even more regret, as it concerns the deservedly honoured names of Gratiolet and of Broca, to whom anthropology owes so much. What is true in the doctrine relates, among other things, to what is matter of common observation as to the fore part of the head rather than to anything which is really constant in the back part of the skull. This matter of common observation is to the effect that when the ear is "well forward" in the head we do ill to augur well of the intelligence of its owner. Now, the fore part of the brain is irrigated by the carotid arteries, which, though smaller in calibre during the first years of life, during which the brain so nearly attains its full size, than they are in the adult, are nevertheless relatively large even in those early days, and are both absolutely, and relatively to the brain which they have to nourish, much larger than the vertebral arteries, which feed its posterior lobes. It is easy therefore to see that a brain in which the fore part supplied by the carotids has been stinted of due supplies of food, or however stunted in growth, is a brain the entire length and breadth of which is likely to be ill-nourished. As I have never seen reason to believe in any cerebral localisation which was not explicable by a reference to vascular irrigation, it was with much pleasure that I read the remarks of Messrs. Wilks and Moxon in their recently published "Pathological Anatomy," pp. 207, 208, as to the indications furnished by the distribution of the Tacchionian bodies as to differences existing in the blood-currents on the back and those on the fore part of the brain. These remarks are the more valuable, as mere hydraulics, Professor Clifton assures me, would not have so clearly pointed out what the physiological upgrowths seem to indicate. Any increase, again, in the length of the posterior cerebral arteries is *pro tanto* a disadvantage to the parts they feed. If the blood-current, as these facts seem to show, is slower in the posterior lobes of the brain, it is, upon purely physical principles of endosmosis and exosmosis, plain that these segments of the brain are less efficient organs for the mind to work with; and here again, "occipital dolichocephaly" would have a justification, though one founded on the facts of the nutrition of the brain-cells, not on the proportions of the braincase. In many (but not in all) parts of Continental Europe, again, the epithet "long-headed" would not have the laudatory connotation which, thanks to our Saxon blood, and in spite of the existence amongst us of other varieties of dolichocephaly, it still retains here. Now, the brachycephalic head (which, abroad [‡] at least, is ordinarily a more capacious one, and carried on more vigorous shoulders and by more vigorous owners altogether, than the dolichocephalic, strikes a man who has been used to live amongst dolichocephali by nothing more forcibly, when he first comes to take notice of it, than by the nearness of its external ear to the back of the head; and this may be said to constitute an artistic occipital brachycephalism. But this does not imply that the converse condition is to be found conversely correlated, nor does it justify the use of the phrase "occipital dolichocephaly" in any etymological, nor even in any ethnographical, sense.

I shall now content myself, as far as craniology is concerned, by an enumeration of some at least of the various recent memoirs upon the subject which appear to me to be of pre-eminent value. And foremost amongst these I will mention Professor Cleland's long and elaborate scientific and artistic paper on the Variations of the Human Skull, which appear in the "Philosophical Transactions" for 1869. Next I will name Ecker's admirable, though shorter, memoir on Cranial Curvature, which appeared in the "Archiv für Anthropologie," a journal already owing much to his labours, in the year 1871. Aeby's writings I have already referred to, and Ihering's, to be found in recent numbers of the "Archiv für Anthropologie" and the "Zeitschrift für Ethnologie," deserve your notice. Professor Bischoff's paper on the Mutual Relations of the horizontal circumference of the Skull and of its contents to each other and to the weight of the Brain, has not, as I think, obtained the notice which it deserves. It is to be found in the "Proceedings" of the Royal Society of Munich for 1864, the same year which witnessed the publication of the now constantly quoted "Crania Helvetica," of Professors His and Rütimeyer. Some of the most important results contained in this work, and much important matters besides, was made advailable to the exclusively English reader by Professor Huxley two years later, in the "Pre-historic Remains of Caithness." I have made a list, perhaps not an exhaustive one, but containing some dozen memoirs by Dr. Beddoe, and having read them or nearly all of them, I can with a very safe conscience recommend you all to do the like. I can say nearly the same as regards Broca and Virchow, adding that the former of these two *savans* has set the other two with whom I have coupled him an excellent example, by collecting and publishing his papers in consecutive volumes.

But I should forget not only what is due to the place in which I am speaking, but what is due to the subject I am here concerned with, if, in speaking of its literature, I omitted the name of your own townsman, Prichard. He has been called, and, I think, justly, the "father of modern anthropology." I am but putting the same thing in other words, and adding something more specific to it, when I compare his works to those of Gibbon and Thirlwall, and say that they have attained and seem likely to maintain permanently a position and importance commensurate with that of the "stately and undecaying" productions of those great English historians. Subsequently to the first appearance of those histories other works have appeared by other authors, who have dealt in them with the same periods of time. I have no wish to depreciate those works; their authors have not rarely rectified a slip and corrected an error into which their great predecessors had fallen. Nay, more, the later comers have by no means neglected to avail themselves of the advantages which the increase of knowledge and the vast political experience of the last thirty years have put at their disposal, and they have thus occasionally had opportunities of showing more of the true proportions and relations of even great events and catastrophes. Still the older works retain a lasting value, and will remain as solid testimonies to English intellect and English capacity for large undertakings as long as our now rapidly extending language and literature live. The same may be most truthfully said of Prichard's "Researches into the Physical History of Mankind." An increase of knowledge may supply us with fresh and with stronger arguments than he could command for some of the great conclusions for which he contended; such, notably, has been the case in the question (though question it can no longer be called) of the Unity of the human species; and by the employment of the philosophy of continuity and the doctrine of evolution, with which the world was not made acquainted till more than ten years after Prichard's death, many a weaker man than he has been enabled to bind into more readily manageable burdens the vast collections of facts with which he had to deal. Still his works remain, massive, impressive, enduring—much as the headlands along our southern coast stand out in the distance in their own grand outlines, whilst a close and minute inspection is necessary for the discernment of the forts and fosses added to them, indeed dug out of their substance in recent times. If we consider what the condition of the subject was when Prichard addressed himself to it, we shall be the better qualified to take and make an estimate of his merits. This Prichard has himself described to us, in a passage to be found in the preface to the third volume of the third edition of the "Physical History," published in the year 1841, and reminding one forcibly of a similar utterance of Aristotle's at the end of one of his logical treatises (Soph. Elench. cap. xxxiv. 6). These are his words:—

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[*] Aeby, "Schadelform des Menschen und der Affen," pp. 11, 12, and 128.

[†] Weisbach, "Die Schädelform der Roumanen," p. 32, 1869.

[‡] See upon this point:—Broca, Bull. Soc. Anth. Paris, ii. p. 648, 1861; *ibid.* Dec. 5, 1872; Virchow, Archiv für Anth. v. p. 535; Zeitschrift für Ethnol. iv. 2, p. 36; Sammlungen, ix. 193, p. 45, 1874; Beddoe, Mem. Anth. Soc. Lond. ii. p. 350.

"No other writer has surveyed the same field, or any great part of it, from a similar point of view. . . . The lucubrations of Herder and other diffuse writers of the same description, while some of them possess a merit of their own, are not concerned in the same design, or directed towards the same scope. Their object is to portray national character as resulting from combined influences—physical, moral, and political. They abound in generalisations, often in the speculative flights of a discursive fancy, and afford little or no aid for the close induction from facts, which is the aim of the present work. Nor have these inquiries often come within the view of writers on geography, though the history of the globe is very incomplete without that of its human inhabitants." A generation has scarcely passed away since these words were published in 1841; we are living in 1875; yet what a change has been effected in the condition of anthropological literature! The existence of such a dignified quarterly as the "Archiv für Anthropologie," bearing on its title-page in alphabetical order the honoured names of V. Baer, of Desor, of Ecker, of Hellwald, of His, of Lindenschmidt, of Lucæ, of Rütimeyer, of Schaafhausen, of Semper, of Virchow, of Vogt, and of Welcker, is in itself perhaps the most striking evidence of the advance made in this time, as being the most distinctly ponderable and in every sense the largest anthropological publication of the day.

Archæology, which but a short time back was studied in a way which admirably qualified its devotees for being called "connoisseurs," but which scarcely qualified them for being called men of science, has by its alliance with natural history and its adoption of natural history methods, and its availing itself of the light afforded by the great natural history principles just alluded to, entered on a new career. There is, as regards natural history, anatomy, and pathology, nothing left to be desired for the conjoint scheme represented by the periodical just mentioned, where we have V. Baer for the first and Virchow for the last, and the other names specified for the rest of these subjects; whilst archæology, the other party in the alliance, is very adequately represented by Lindenschmidt alone. But when I recollect that Prichard published a work "On the Eastern Origin of the Celtic Nations" ten years before the volume of "Researches," from which I have just quoted, and that this work has been spoken of as the work "which has made the greatest advance in Comparative Philology during the present century," I cannot but feel that the Redaction of the "Archiv für Anthropologie" have not as yet learnt all that may be learnt from the Bristol Ethnologist; and they would do well to add to the very strong staff represented on their title-page the name of some one, or the names of more than one comparative philologist. This the Berlin "Zeitschrift" has done.

Prof. Rolleston concluded by a few words on the possible curative application of some of the leading principles of modern Anthropology to some of the prevalent errors of the day.

MEETING OF THE ASTRONOMISCHE GESELLSCHAFT AT LEYDEN, AUGUST 13-16.

THE sixth biennial meeting of the Astronomische Gesellschaft, founded in the year 1863, at Heidelberg took place this year at Leyden, according to the international character of the Society, and in conformity with the resolution of the last meeting at Hamburg. The first session was opened by the President, O. Struve, in the rooms of the magnificent Observatory at Leyden. Besides him were present the following members: Auerbach, Bruhns, Engelmann, Scheibner, and Zöllner from Leipzig; Winnecke, and Hartwig from Strassburg; H. G. Bakhuyzen, E. F. Bakhuyzen, Kaiser, Schlegel and Valentiner, from Leyden; Gyldèn from Stockholm, Repsold from Hamburg, v. d. Willigen from Harlem, Förster and Tietjen from Berlin, Seeliger from Bonn, Bruns from Dorpat, Kortazzi from Nikolajew, Palisa from Pola, Bosscha from the Hague, Block from Odesa.

After an address from the Curator of the Leyden University, Baron Gevers van Endegeest, in which he spoke of the great merits of the late Director of the Leyden Observatory, the eminent Kaiser, and his exertions in promoting astronomical studies in Netherland, the usual statistical notices were read.

The President stated that after the conclusion of the Hamburg meeting the number of members was 231, that 28 new members had been admitted, while the loss by death or otherwise had been 24, so that the actual number of members was 235. He gave biographical notices of some of the deceased members, Hoek, Mödler, Argelander, Winlock, and d'Arrest. The treasurer, Auerbach, read the balance of the two last years' income and expenses; the secretary, Prof. Winnecke, reported that the publications of the Gesellschaft published were: Publication No. xiii.; Spörer, "Beobachtungen der Sonnenflecken zu Anelam mit 23 Tafeln," and "Vierteljahrsschrift der Astron. Gesellschaft," (vol. viii., 3, 4, vol. ix., vol. x., 1, 2, 3). Prof. Scheibner reported on the library and mentioned, amongst others, the very valuable gift of all the manuscripts of the great astronomer of Gotha, Hansen, made by his widow to the society.

Prof. Bruhns gave an account of the progress of work on comets, undertaken by the Society. Of especial interest was the communication and discussion on Encke's comet.

Prof. Scheibner presented the first copy of a posthumous memoir of Hansen on the Pertubations of Jupiter, and explained the present state of the undertaking.

Prof. Bruhns exhibited an apparatus for the graphical solution of Kepler's problem, and explained its use. The same communicated a description of a new photometer, the execution of which was in progress. Prof. Zöllner explained then, by a model, some improvements of his well-known photometer, through which it becomes more easily adapted to all kinds of telescopes. Some observations of Mars, made by Kononewitsch, appear to indicate a real diminution in the brightness of Mars.

Prof. Bakhuyzen laid before the Society two manuscript volumes, bought lately by the Leyden Observatory, "the Areographischen Fragmente by Schröter" long reputed to be lost. Besides these, he exhibited the very interesting diagrams of Mars made two centuries ago by the celebrated Huyghens.

Dr. Engelmann of Leipzig announced that he is preparing for press an edition of Bessel's various smaller papers.

At the second meeting, August 14, the members Astrand (Bergen), Gelmuyden (Christiania), Hohwü (Amsterdam), Neumayer (Berlin) were present, and six new members were admitted.

The Council gave the Report on the progress of the Meridional Zone work by which all stars down to the 9th inclination between 80° north and 2 south declination are catalogued. The following observatories partake in this great work: Kasan, Dorpat, Christiania, Helsingfors, Cambridge (U.S.), Bonn, Chicago, Leyden, Cambridge (England), Berlin, Leipzig, Neuenburg, Nikolajew.

It was then to be decided where the Gesellshaft would meet the next time. After an invitation by Prof. Gyldèn from Stockholm, the Gesellshaft decided on Stockholm for the seventh biennial meeting.

Prof. Förster of Berlin made a detailed communication on the situation of different Astronomical Institutions of Berlin, including those which are in the course of construction. The erection of the Astro-physical Observatory near Potsdam is in good progress. It has not yet been possible to appoint a Director for this extensive institution; meanwhile the services of Prof. Spörer, Dr. Vogel, and Dr. Lohse are secured for it. This new institution is intended to promote science principally in the higher optics, and their application to astronomy, while the Observatory at Berlin and the Institution for exact Numerical Computation under the direction of Prof. Tietjen will pursue their given ways.

Prof. Bakhuyzen exhibited a new wire micrometer, sent by Merz, and explained its pecularities. Prof. Gyldèn gave a new solution of Kepler's problem with the aid of elliptical functions, and distributed some copies of a memoir on the use of elliptical integrals in the theory of the motion of the heavenly bodies. Dr. Palisa explained the construction of the new meridian circle at Pola by many large plates. Different papers sent to the meeting by Astrand, Covarrubias, Lockyer, and Struve were laid on the table.

The Observatory at Brussels appears, after the loss of its founder and genial director, Professor Quetelet, to be in a critical position. The Astronomische Gesellshaft resolved unanimously, that it is to be wished that the distinguished activity exhibited by the Brussels Observatory in the determination of the places of stars with sensible proper motion, may be maintained, and if possible, improved by completing its instrumental means. It is in the interest of science to reduce and print the results of the measures in question as soon as possible.

At the third meeting, August 16, Covarrubias from Mexico, and Metzger from Java were present.

After the discussion of various business matters, the Zone observations, the computations on minor planets, and the reduction of the observations made during the transit of Venus 1874, December 8, Engineer Metzger made from Java different communications on the astronomical and geodetical proceedings at Java. Professor Scheibner spoke on the use of the theory of elliptical functions in the theory of perturbations, and communicated a prize-question concerning this matter by the Tablonowski Society at Leipzig. He also communicated very interesting results of his researches in dioptrics.—Professor Neumayer gave a statement on the regulations and field of labour of the Hydrographical Office at Berlin, and of the Scientific Institutions under its direction, the Observatory at Wilhelmshaven and the Deutsche Seewarte at Hamburg. Professor Winnecke described the new orbit-sweeper of the Strasburg Observatory, and announced the beginning of a review of the nebula. The equipment of the new Observatory at Strasburg is made with the direct intention of activity in this branch of astronomy.—Professor Bruhns remarked, that at the Leipzig Observatory charts for the nebula are made, which are visible in a comet-seeker.—Professor Bakhuyzen communicated his researches on the latitude of Greenwich, and its diminution in the later years.

The election of the New Council concluded the meeting: President, Professor Struve; Vice-President, Professor Bruhns; Secretaries, Professors Schönfeld and Winnecke.

NOTES

THE *Valorous*, which accompanied the two Arctic ships, the *Alert* and the *Discovery*, as far as Disco, with coals and provisions, arrived at Plymouth on Sunday. She has really nothing remarkable to tell, which is so far satisfactory. Severe storms were met with in crossing the Atlantic, but all three vessels seem to have borne themselves well, though the *Alert* and *Discovery* each lost a whale boat, a loss which was made up to them by the *Valorous* before leaving Disco. The *Valorous* was the first to reach Disco, which she did on July 4, the other two not coming up till the 6th. The ships remained together at Disco till the 15th, the two exploring vessels filling up from their consort as much coals and provisions as they could stow away. During their stay at Disco, officers and men seem to have enjoyed themselves and to have been treated with the greatest courtesy and kindness by the Danish officials and the natives. Mr. Kraup Smith, the Inspector of North Greenland, had orders from his Government to pay every attention to the Expedition, and he carried out his instructions most liberally. He provided the Expedition with sixty-four dogs and an Esquimaux. While at Disco the naturalists of the three ships were employed collecting botanical and geological specimens on shore and dredging in and outside the harbour. A very large number of plants were found, some believed to have been previously unknown in this part of Greenland. The *Alert* and *Discovery* having been put into complete trim, the Expedition left Godhavn on July 15, and on the 16th the *Valorous* took leave of her consort ships, after seeing them fairly on their way to their work in the high north. The Danish officials' reports as to the weather are favourable, leading to the belief that the navigation of Melville Bay and northwards will be comparatively easy. It is hoped that suitable winter quarters will be found for the *Discovery* on the north shore of Lady Franklin's Strait, from whence hunting parties will issue. The *Alert* will then press onwards alone to the north, landing depots, building cairns with records at intervals of about sixty miles. The surest way of reaching the Pole, in Captain Nares's opinion, is not to risk failure by pushing forward away from the land. The *Alert* will probably winter in 84° and begin sledge travelling so as to get information of the country, and then in the summer of 1876 will push boldly northwards. The grand achievement will be done by a system of depots and auxiliary sledges, enabling the foremost to be absent about 112 days, and to advance upwards of 500 miles from the ship. The *Discovery*, in the meantime, will go on exploring and advancing slowly. At the British Association on Tuesday, a paper by Mr. C. H. Markham, who accompanied his cousin to Disco in the *Alert*, was read; and Mr. Carpenter, who with Dr. Gwyn Jeffreys sailed in the *Valorous* for dredging purposes, added a few words. He said, when they parted with the *Alert* and *Discovery* they had every reason to believe from the state of the wind and weather that the Expedition would go on favourably. He thought it was more than probable that the *Discovery* was now in her winter quarters, and the *Alert* was somewhere further north. The letters which the ships would deposit would probably reach England before Christmas, and after that it is not likely they would hear anything of them until next summer, or perhaps later. On its way home the *Valorous* struck on a sunken rock to the north of Holsteinberg, but happily came off without serious damage. Temperature, soundings, and dredgings were made by the *Valorous* in its homeward journey, many interesting forms having been obtained. In a series of temperature soundings taken, 33° and a decimal was found to be the lowest. When the *Valorous* parted with the Expedition everybody on board the two ships was in perfect health.

THE annual meeting of the Ray Society was held at Bristol on Friday; Sir Philip Egerton presided. The Report of the Council stated that the arrears in the issue of volumes were at last overcome. The volumes for 1873 and 1874 had been distributed, and much advance had been made in the "Memoir on the Aphides," by Mr. G. B. Buckton, proposed as the volume for 1875. The very beautiful plates drawn and presented to the Society by Mr. Buckton are now with the colourer, and the whole will be sent to the binder probably in November. In addition to Mr. Mivart's monograph on the Tailed Amphibia, and Prof. Westwood's on the Mantidæ, Mr. G. Brady has promised a work on the Copepoda, and it is found that the MSS. and sketches of the late Mr. Hancock are sufficient to complete the long-promised monograph on the British Tunicata. The balance-sheet showed over 214*l.* in hand. The names of Prof. Bentley, Mr. Hudson, Dr. Gwyn Jeffreys, and Mr. Mennell were withdrawn from the Council, and those of Dr. A. Carpenter, Mr. Collinson, Mr. Currey, and Dr. Millar were substituted for them. Sir Philip Egerton was re-elected president, Mr. S. J. A. Salter treasurer, and the Rev. Thomas Wiltshire secretary; and cordial votes of thanks were given to them for their services.

THE Nantes Meeting of the French Association for the Advancement of Science was brought to a close last Thursday. It has been decided with much propriety that next year's meeting will be held at Clermont Ferrand, where the new Observatory of Puy de Dome is sure to prove a great attraction. The Observatory will be then in working order, and everything will be ready for the inspection of visitors. Havre has been chosen as the meeting-place for 1877. This meeting is sure to be a success, Havre being almost to Paris what Brighton is to London. M. Dumas has been appointed a vice-president of the permanent council in room of M. Faye, who has resigned. The accession of M. Dumas in the governing body is sure to infuse new life into the Association. Most of the foreigners present belonged to Oriental nations, being Greeks, Ottomans, or Persians. We hope to give an abstract of the proceedings next week.

THE twelfth congress of the Italian Scientific Associations was opened at Palermo on Aug. 29 by Count Mamiani, in presence of an audience exceeding two thousand persons. Count Mamiani began by thanking the Municipality of Palermo for the hospitable reception it had given brother Italians as well as strangers, and explained that the future Congress will assemble under the new name of the Italian Association for the Promotion of Science. No longer representing a little aristocracy of *savants*, it would embrace all Italy. Nothing nowadays can flourish which has not its root in the people. Great individuals have given place to the co-operating multitude, and the sole thing left for the people to reverence is science—the one surviving deity on the deserts of Olympus. In Palermo, the city of the chivalric Normans and the knightly Suabian Frederic, chivalry survives, but its tournaments are philosophical discussions, and its mistress is science, which is the immortal poetry of nature and truth. Count Mamiani then signalised Sicily's services to science, and spoke of what she will yet do for meteorology.

PETERMANN'S *Mittheilungen* for September will contain the following among other papers:—On the Linguistic Divisions of Elsass-Lothringen, with a map coloured to show the districts in which Dutch, German, and mixed Dutch and French are spoken.—Travels in the Republic of Guatemala in 1870, by Dr. G. Bernouilli, concluded from previous numbers.—Remarks on a Map of Western Australia, which will accompany the number.—Under the title of "Bilder aus dem hohen Norden," Lieut. Weyprecht will commence a series of Sketches of Phenomena in the Arctic Regions; the article in the September number dealing with the Aurora and the Ice.

M. BRAZZA, an ensign in the French navy, and M. Marche, a traveller, who has already made important discoveries on the banks of the Ogové, left Paris last week for Toulon, in order to resume the exploration of Tropical Africa, and to discover the sources of the river just named. They will stay for some time Saint Louis, the chief town of the Senegal settlements, and recruit a number of Laptots chosen from among the negroes engaged under the French colours. The expedition is supported by the Society of Geography, private subscriptions, and a small grant given by the French Government. The principal resource is the sale of objects of natural history, which are so numerous in a country rich in plants, birds, and animals of every description. They are to be sent to M. Bouvier, the well-known naturalist of Paris, and catalogues will from time to time be circulated. The exploration will last for five years.

M. LEVERRIER has published in the Paris papers a notice intimating that the Observatory will be opened for observations three times a week, from half-past seven, weather permitting. Two large telescopes are placed at the disposal of visitors, who may procure a letter of admission by writing to the Secretary of the Observatory.

THE reforms which the French Minister of Public Instruction is preparing for the next University term are so numerous that no holidays will be granted to the *employés* of the Ministry of Public Instruction this year.

THE French Government have published in the *Journal Officiel* of August 24 a decree notifying the precautions to be observed by manufacturers of explosives in which dynamite is the base. The precautions, which are numerous, have been most carefully drawn up by a special commission, and are worthy of general attention.

IN the Paris International Maritime Exhibition there is a small object deserving of notice. It is a platinum wire placed in a bottle and ignited by electricity from a bichromate battery. It is intended to be immersed in the sea, and the light emanating from it is said to attract an immense number of fishes. Experiments have been tried lately on the coast of the Côtes du Nord department with a fishing-boat, and have proved very satisfactory, on a bank of sardines. The glass must be green or black, otherwise the fish are frightened by the glare and do not follow the submarine light.

THE *Civilian* states that Major-Gen. Cameron, R.E., C.B., has been appointed Director of the Ordnance Survey of Great Britain and Ireland.

THE Russian expedition to Hissar has resulted in a complete elucidation, from a scientific point of view, of the questions connected with the Hissar and Kuliaba rivers. All the important towns in the country have been visited, astronomical observations have been taken at fourteen places, and the members of the expedition are in a position to draw up a complete map of the country. Moreover, a map of military routes has been draughted and an entomological collection has been made. The Expedition has discovered that the Turkham river, whose very existence was so long doubted by geographers, is one of the most important tributaries to the Amu, and that the Drongate Pass, now called Busgol Kham, fully bears out the formidable accounts of Asiatic travellers.

THE additions to the Zoological Society's Gardens during the past week include five Bonnet Monkeys (*Macacus radiatus*) from India; a Yellow Baboon (*Cynocephalus babouin*), and a Sykes's Monkey (*Cercopithecus albigularis*), from W. Africa, presented by Mr. J. B. Tunnard; a Common Marmoset (*Hapale jacchus*) from S. E. Brazil, presented by Mrs. Puente; a Darwin's Pucras (*Pucrasia darwini*) from China; an Indian Cobra (*Naja tripudians*) from India, deposited; and an Axis Deer (*Cervus axis*) born in the Gardens.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 23.—M. Frémy in the chair. The following papers were read:—Comparison of the theory of Saturn with the observations; Tables of Saturn's motion; by M. Leverrier.—Theorems into which a condition of equality of two rectilinear segments enters, by M. Chasles.—MM. Ch. Galbruner, F. Crôtte, and Lesthevenson, made several communications with regard to Phylloxera.—A note by M. Declat on the pathological use of phenylic acid, and of phenylate of ammonia.—A note by M. de Fonvielle on a new method to determine the path described by a balloon.—On the integration of a system of equations with partial differentials, by M. N. Nicolaïdes.—On the trisection of an angle by aid of the compass, by M. Ed. Lucas.—On the properties of the diameters of wave-surfaces and the physical interpretation of these properties, by M. A. Mannheim.—On a compound of platinum, tin, and oxygen, analogous to Cassius' gold purple (platinostannic oxide of M. Dumas), by MM. B. Delachanal and A. Mermet.—On bankoul oil, by M. E. Heckel.—A reply to M. Gauthier's objections regarding the rôle of carbonic acid in the spontaneous coagulation of blood, by MM. E. Mathieu and V. Urbain.—Note on the last elements at which it is possible to arrive by histological analysis of striated muscles; by M. A. Ronjon.—On the shooting stars of August, 1875, by M. Chapelas.

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THURSDAY, SEPTEMBER 9, 1875

THE SCIENCE COMMISSION REPORT ON THE ADVANCEMENT OF SCIENCE*

UNDER head III. is brought forward the "Evidence relating to the Establishment of Physical Observatories."

On the general question of the establishment and maintenance of Physical Observatories, Lord Salisbury agrees that—

". . . Some of these institutions which have been alluded to in your grace's question, especially observatories, clearly fall within the duties of the Government; and certainly, from all that one hears, it is probable that their duty in that respect is inadequately performed, and that observatories for a much larger range of observations might with great advantage be multiplied." . . . .

Sir George Airy, Astronomer Royal, thus states his view on the subject:—

"When I began to be an astronomer, such questions as those of the constitution of the sun and the like were not entertained." . . . .

"Are you prepared to express an opinion as to whether it is an object which would be a proper one for the Government to take up as a State Establishment?—The Government are already pushed very hard in their estimates. The screw is always put upon them, 'Cannot you reduce the estimates a little more?' And then it would always come to a question of extensive feeling in the House of Commons, and of popular feeling out of the House of Commons; and I am confident from what I have seen that those two bodies would not in every case support an extension." . . . .

"Should you say that it is an object which is not very likely to be prosecuted with sufficient vigour unless taken up by the Government?—I do not see how it could go on except it were taken up by the Government. I do not believe that it could go on in any other way."

"It is not likely, you think, to be prosecuted by private individuals, or by other public bodies such as the Universities?—No, I think that their funds are almost all required for other objects, and the difficulty even of getting the business into shape is extremely great." . . . .

"Then such observations, in all probability, will either not be made at all or must be taken up by the Government?—That is my view." . . . .

Mr. De la Rue's opinion is thus given in reply to question 13,066:—

"I think that the time for the State providing means for reducing observations has now come: when the State should take up, besides mathematical astronomy (which deals with the places of the stars and planets, and the moon especially), physical observations, more particularly observations of the sun, which appear to me to bear directly upon meteorological phenomena." . . . .

Sir W. Thomson points out the importance of multiplying such Observatories:—

". . . In respect to the observatories, it might be necessary to have several observatories for astronomical physics in this country, if it were only to secure observations of interesting conjunctures, notwithstanding the varieties of the weather, that there may be in different parts of the country; and, again, observatories for astronomical physics ought most certainly to be founded in other parts of the British dominions than England, Ireland, and Scotland; in other latitudes and on the other side of the world."

Dr. Siemens expresses the same view in the following evidence:—

". . . An observatory or several observatories should be established for carrying on physical research, research to obtain information on general subjects, such as solar observations, magnetic observations, and other subjects that might be thought desirable to obtain continually information upon." . . .

"I think that almost the only new establishments which you recommend are certain physical observatories?—Yes."

"What would be the principal object of such observatories?—For the purpose of magnetic observations, solar observations, and other general inquiries into physical phenomena."

"Do you contemplate the establishment of more than one such observatory?—Probably more than one would be desirable."

"Do you contemplate the establishment of any such observatories in any of the colonial possessions of the country?—Yes, I think so."

"Speaking generally, would they be costly establishments to found?—Not very costly, not so costly as astronomical observatories."

Dr. Frankland has also given evidence on the importance of promoting the study of Astronomical Physics, pointing out that "it would be necessary, in connection with the Physico-Astronomical Observatory, to have the means of performing various chemical experiments and making physical observations. Of course the chemical operations would be quite subsidiary to the cosmical observations there."

Mr. De la Rue, in reference to locality and organisation, in answer to the question whether provision for carrying out observations of this character should be in connection with the Greenwich Observatory, says:—

"In connection with the Greenwich Observatory, yes, but at the Greenwich Observatory, I should say not. I do not think, in the first place, that there is space enough at Greenwich, and the duties of the staff are already so very onerous that it would require a separate establishment for such special work; besides other new buildings it would entail a chemical laboratory, and there is hardly space for those at Greenwich. I believe also that it would cause too divided attention on the part of the Astronomer Royal, if he were called upon to personally superintend investigations in the physics of astronomy, although I think it would be very desirable that any new establishments, if they are to exist, should be affiliated to Greenwich."

Admiral Richards, late Hydrographer to the Admiralty, and a Visitor of the Royal Observatory, Greenwich, says:—

"If you are going permanently to establish physical observatories, I should prefer to see separate ones. I think that the physical work probably would be better separated from the Royal Observatory."

"You think that the two classes of observations are so distinct in character as to render that desirable?—Of course there is a certain amount of meteorology that must be observed at the astronomical observatory; but it need not be of any extended character."

A resolution in general accordance with the views expressed by Sir George Airy was transmitted to the Commission in July 1872, by the President and Council of the Royal Astronomical Society. This resolution is in favour of the extension of the Royal Observatory at Greenwich and other existing Astronomical Observatories, and does not recommend the establishment of an independent Government observatory for the cultivation of astronomical physics in England.

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* Continued from p. 364.

In connection with some points on which differences of opinion have been expressed in this evidence, a paper was handed in by Col. Strange, consisting of questions addressed by him to Prof. Sir W. Thomson, Prof. Hilgard, the Secretary of the American National Academy of Sciences, and Prof. Balfour Stewart, and to M. Faye, the President of the French Academy of Science.

Col. Strange's questions were as follows :—

"1. Is the systematic study of the solar constitution likely to throw light on subjects of terrestrial physics, such as meteorology and magnetism?

"2. What means, at present known to science, are available for studying the sun?

"3. Do you consider that photography (one of the assumed means) will suffice for the purpose?

"4. Do you consider that the class of observations (defined in your answer to my question 2) are such as can be efficiently made in an observatory maintained by the State, or that any of them would be better left to the zeal of volunteer astronomers?

"5. Do you consider that it would be advantageous to carry on physico-astronomical researches on an extensive scale, and meridional observations, in one and the same observatory, under a single director?"

We regret that our space will not permit us to give the replies of these eminent men to Col. Strange's questions. They were, however, strongly in favour of the establishment of physical observatories on a footing quite distinct from existing meridional observatories, and equipped with the laboratories and workshops without which such institutions would be useless. We commend to all who are interested in this question the perusal of this correspondence, which is to be found as Appendix vii. to vol. ii. pp. 27-31. Its value is enhanced by the fact that two of the writers, Prof. Hilgard and M. Faye, are distinguished foreign men of science.

Evidence relating to Meteorology.

Under this head a considerable amount of evidence was taken, particularly as to the constitution, objects, and results of the Meteorological Office.

This Office is under the management of the Meteorological Committee of the Royal Society, the functions of which are thus described in the report annually presented to Parliament :—

"The Meteorological Committee consists of Fellows of the Royal Society who were nominated by its President and Council, at the request of the Board of Trade, for the purpose of superintending the meteorological duties formerly undertaken by a Government Department, under the charge of Admiral Fitzroy.

"The Committee are credited with a sum of 10,000*l.* voted annually in the Estimates, for the administration of which they are wholly responsible, and over which they are given the entire control.

"The meetings of the Committee are held once a fortnight, or oftener when necessary, when every subject on which action has to be taken by their executive officers receives their careful consideration. The duties of the Committee are onerous and *entirely gratuitous;* they were accepted and are very willingly performed by the members, on account of the earnest desire they severally feel for the improvement of meteorological science."

The position of the Committee is anomalous. In the words of the director of the Meteorological Office—

"The Government distinctly disclaims all connection with us, whilst the Royal Society equally disclaims all control over us, except merely the nomination of the members of the Committee."

"As a matter of fact, all that the Royal Society does is to nominate the members of the Committee?—That is all."

"Having so done, it ceases to have any control whatever, does it not?—Entirely."

"What is the precise relation between the Office and the Government?—That the Government gives a vote of 10,000*l.* every year, and that it calls for no account of this money excepting the account annually presented to Parliament."

"Who audits the accounts?—The members of the Committee. There is no formal audit, because, as the Government would not recognise any audit excepting its own, the Committee considered that it was not worth while paying an auditor if such audit would not be recognised, and, as a matter of fact, two of the members take the trouble of auditing the accounts every year."

"What, in your opinion, are the chief advantages and disadvantages of such an arrangement as compared with those of the direct management of the Office by the Government?—The chief advantage is the perfect freedom from political management. The risk in being connected with the Government is that if a new President of the Board of Trade comes, he may reverse the action of the preceding one. The existence of a scientific supervision for the Office is exceedingly important; it acts as an intermediate party between the public and the Office. I may mention a decided disadvantage which results from the Office not being connected with the Government, namely, the loss of prestige. The difficulty is, that if we are sending instruments by sea or by railroad, if we do not call them Government instruments we cannot get as much attention paid to them; and it is my opinion that we should get more co-operation from the merchant navy if we were an office of the Board of Trade. We should have more prestige as acting directly from the Government."

A very clear account of the objects which the Meteorological Committee propose to themselves is given in the evidence of Major-General Strachey, one of the members :—

The Commissioners remark that it is admitted that the objects thus described do not exhaust the whole of meteorology, and that the Committee in their selection of these objects have been, to a great extent, guided by the proceedings of the Meteorological Department of the Board of Trade, which existed prior to, and which has been superseded by the Committee. Thus Major-General Strachey says :—

"The Committee is now in reality doing no more than continuing the exercise of certain functions which had, in the course of time, been thrown upon the Board of Trade by the position which that department occupies in connection with the public administration."

"Has the consequence been that the action of the Committee has been from the outset rather in a practical direction than in one of original research or scientific observation, properly so called?—I think distinctly that such is the case, and that it has necessarily followed from the position in which the Committee was placed. If a reference is made to the earlier papers, and to the report of the gentlemen on whose suggestions the present arrangements originated, there perhaps is an indication that they anticipated something more in the way of scientific research than has actually occurred; but the turn that things have taken seems to me the necessary result of the sort of duties that were put upon the Committee under the essential condition that it had but a limited sum of money to spend."

"Have any results of scientific importance in your opinion been obtained by the action of the Committee?—In the direction of what one may call investigation of an absolutely scientific character, I should say none at all. Of course the observations that are made at the special observatories are valuable scientific information, and so far one has no right to say that scientific results have not been produced; but I do not think that these can properly be referred to as specific results of anything that the Committee has done. To the best of my belief there has been nothing undertaken in the way of original investigation into the specific physical causes of any of the phenomena which are recorded, nor any original research, properly so called, in relation to any of the several branches of meteorology. The Committee hardly has appliances at its command for any such investigations, and, the funds at its disposal being limited, it was hardly possible that it should attempt them. It is also no doubt quite true that the observations which are made at the seven observatories do not include any matters which are of great importance in physical science, and which would properly come within the range of meteorology."

"Are the funds at the disposal of the Committee in your opinion insufficient for doing anything more than has been actually done at present?—I should say distinctly that this is the case. The Committee has always considered that it is bound to attend primarily to the special objects before referred to, which were in a specific manner made over to it, and it finds that after this has been done there is no money left for other things."

Again, the same witness expressed a decided opinion that the State should do more for the promotion of meteorological science than it does at present, but entertains some doubt whether any increased duties could advantageously be allowed to devolve upon a body such as the Meteorological Committee.

The same view is expressed by Professor Balfour Stewart:—

"Would you organise the Meteorological Committee in any really different form to that which at present obtains?—I should be inclined to dispense with the Meteorological Committee altogether, and substitute a Meteorologist Royal, or whatever his appellation might be, a single official who should be responsible to the Government in the same way as the Astronomer Royal is responsible for his department. I do not see why the one department should be on one footing and the other department on a different footing. I think that there are grave disadvantages with a department administered by an unpaid committee."

"Would you appoint a Meteorologist Royal corresponding with the Astronomer Royal?—Yes, whatever the name might be; I should appoint an official very much corresponding to the Astronomer Royal, and responsible to the same extent. A board of visitors would not be objectionable, but the direction of an unpaid committee appears to me to be very objectionable."*

Evidence relating to Tidal Observations.

Evidence in reference to tidal observations has been placed before the Commission by Dr. Joule and Prof. Sir W. Thomson.

Dr. Joule is of opinion that—

"With regard to the sea level and the tides, although the laws with regard to the tides are pretty well known, they ought to be continuously observed, if only for the purpose of registering the changes arising from the alteration of banks, depth of channels, &c. Also with regard to the sea level, there have been reports from time to time with regard to the inroads of the sea on our coasts, but sufficient steps do not appear to have been taken to ascertain the facts in those cases. It seems to me very important to be acquainted with any alterations in the configuration of the earth which may be taking place, however minute those alterations may be."

Sir W. Thomson gives the following evidence on this point:—

"In addition to those institutions which you have recommended, you consider, do you not, that it would be advisable that the Government should undertake secular observations of the tides?—Yes, certainly, secular observations of the tides with accurate self-registering tide gauges, with the triple object of investigating the science of the tides, of perfecting our knowledge of the actual phenomena of the tides, both in respect to navigation and as a branch of natural history, and, thirdly, with a view to ascertaining the changes of the sea level from century to century."

"Is anything of the kind done at present?—There are several tide gauges, some of which have been carried on with great care, others with not sufficient care, and none with any security of permanence."

"Was not it in connection with the Ordnance Survey of Great Britain?—No sufficient steps have been taken to ascertain whether the sea level is changing relatively to the land in any part of this country."

The Commissioners state that the accurate reduction of tidal observations, without which, of course, they are useless, has not hitherto been undertaken by any department of the State, and we are indebted to the zeal of individuals for the results which have been obtained. The reductions are laborious, and require the employment of paid computers. A memorial from the British Association for the Advancement of Science to the Lords Commissioners of the Treasury, put in evidence by Sir William Thomson, shows the difficulty that has been felt in procuring the moderate sum required for the reductions, the amount asked for being only 150*l*.

The Lords Commissioners of the Treasury did not accede to the prayer of the memorial, so that at present there is no guarantee that the observations which have already been accumulated, and those which are still in progress, will ever be adequately discussed and utilised.

Evidence relating to the Extension of the Government Grant administered by the Royal Society.

The Commissioners remark: "The strong and concurrent evidence which we have received as to the usefulness of the Government grant, as at present administered by a Committee of the Royal Society, has led us to inquire whether this grant might not be advantageously extended; and the witnesses whom we have examined on this point are unanimous in expressing the opinion that great benefits might be expected from such an extension."

Prof. Owen, Mr. Spottiswoode, Prof. Grant, Mr. De la Rue, and Col. Strange are amongst those who gave evidence to the above effect. Lord Salisbury is also of opinion that the Government grant might be increased, in order to afford liberal assistance to "first-rate workers."

Evidence as to the Payment of Scientific Workers.

The Commissioners remark:—

"On this branch of our inquiry the evidence laid before us, both by statesmen and men of science, is to the same effect, and in favour of increased State aid. It has also especially been urged upon us, that to afford, by direct pecuniary aid, the means of livelihood to men of distinction in pure investigation would be a great advantage to science, as competent investigators would thus be enabled and encouraged to pursue a strictly scientific career."

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* The whole of the evidence, of which the above are curtailed extracts, coincides with the trenchant remark of the Astronomer Royal in his last Report to the Board of Visitors that "The subject of Meteorology hardly deserves the name of a science."

Lord Salisbury is of opinion that the cause of science is hindered by the want of a sufficient career for scientific men, giving the following statement of his reasons:—

"I am induced to think so, by noticing how very much more rapid the progress of research is where there is a commercial value attached to the results of it, than in other cases. The peculiar stimulus which has been given to electrical research, in the particular direction of those parts of it which concern the telegraph, is a very good instance in point, and the extent to which researches into organic chemistry have almost clustered themselves round the production of coal tar colours is another instance in point. And therefore it is difficult to avoid the conclusion that research is really hindered by the necessity under which those who are most competent to conduct it feel themselves, of providing for their own support by means of the talent and the knowledge which they possess."

With regard to the scale on which such remuneration or payments for maintenance should be made, Lord Salisbury observes:—

"I should say, taking the parallel [that of certain offices in the Church], to which I have already alluded, that an income of about 1,000*l*. or 1,500*l*. a year would be the kind of income which would suffice for the purpose that I have in view."

And he would also add provision for retirement.

With reference to the safeguards against abuse which would be necessary, Lord Salisbury continues:—

". . . It would, for their [the investigators'] own interest, and to save them from invidious comments, be desirable to impose upon them the necessity of publishing, either in the form of books or in the form of lectures (but not sufficient in number really to impede their work), an account of the result of their labours during each successive year. Perhaps one or two stated lectures in the course of a year, to be delivered to University students, would be the best means of imposing upon them that test of industry."

Lord Derby takes the same view:—

"I think that, in one way or another, where you have a man of very great eminence as a scientific discoverer, it is unquestionably the duty of the State to provide him with means and leisure to carry on his work. Whether that is to be done by giving him an office under the British Museum, or in any similar institution, or whether it is to be done by simply granting him a pension in recognition of eminent scientific service, or in whatever other way it is done, it seems to me to be immaterial, but I certainly consider that it is a very important part of the public duty, to relieve men who have shown an eminent capacity for original discovery and research from the necessity of engaging in a lower kind of work as a means of livelihood." . . .

Sir W. Thomson, in a reply to which we have already referred, stated his opinion on this point as follows:—

"That men should be enabled to live on scientific research is a matter of most immediate consequence to the honour and welfare of this country. At present a man cannot live on scientific research. If he aspires to devote himself to it he must cast about for a means of supporting himself, and the only generally accepted possibility of being able to support himself is by teaching, and to secure even a very small income, barely sufficient to live upon, by teaching, involves the expenditure of almost his whole time upon it in most situations, so that at present it is really only in intervals of hard work in professions that men not of independent means in this country can apply themselves at all to scientific research." . . .

Prof. Henry, the distinguished director of the Smithsonian Institution in the United States, who was good enough to appear before the Commission when he was in this country, gave the following emphatic evidence in the same direction:—

"My idea would be that if the funds were sufficient, and men could be found capable of advancing science, they should be consecrated to science, and be provided with the means of living above all care for physical wants, and supplied with all the implements necessary to investigation."

Prof. Balfour Stewart, after referring to the instances of wealthy persons who undertake scientific research in this country, points out that the number of those so circumstanced is very small in comparison with the number of able men who are willing to give their time and capacities to observations and research. He goes on to say that able men, and men competent to conduct research, suffer in this country from not having sufficient means at their disposal to proceed as they would like to do.

"Do you anticipate, then, that if there were any intelligent centre for the distribution of a sufficient fund to persons having the requisite capacities for observation and research, but not having the means, the distribution of such a fund would have any benumbing influence upon original observation and research?—No, I should think quite the contrary; it would encourage it very much."

Mr. Gore also advocates the enlargement of the present system.

". . . . I should strongly advocate that the present system should be enlarged, so that the investigators should not merely be reimbursed for all that they have expended, but also paid in some measure for their time and labour, because each investigator has to give up a profitable employment in order to find the time."

He then gives his own personal experience, which probably resembles that of many of those who, without private fortune, engage in pure research.

"I refuse a great many engagements in analyses and other scientific matters for the manufacturers who come to me. . . . I gave up some pupils a short time ago to enable me to have more time for original investigation."

Dr. Joule, Dr. Siemens, Mr. De la Rue, and other scientific authorities testify to the same effect, and urge the adoption of some form of remuneration for valuable work done, as a measure not merely just to the individual, but serviceable to the State by the encouragement it would afford to those able men of small means, who abound in this country, to engage in original researches of great importance to the community.

(*To be continued.*)

THE IRISH FISHERIES

Report of the Inspectors of Irish Fisheries on the Sea and Inland Fisheries of Ireland for 1874. Presented to both Houses of Parliament. (Dublin: Alex. Thom, 1875.)

DURING the last few years increased attention has been paid to the vast stores of food, which this country possesses, in the fish frequenting its inland waters and territorial seas. Legislation, attended on the whole with marked success, has led to the development of the salmon fisheries of the United Kingdom; a much less successful attempt has been made to increase the produce of our exhausted oyster fisheries; and a very able Commission, which enjoyed the advantage of Prof. Huxley's assistance, has investigated and authoritatively disproved the allegation that our sea-fish were decreasing. In England and Scotland, at any rate, satisfaction is usually expressed at this state of things. With the single exception of the oyster, the harvest of the sea proves annually as productive, or even more productive, than ever, while the increasing consumption of a growing population and the greater destructiveness of modern implements of fishing, are not apparently unduly diminishing the numbers of our sea-fish. Ireland, however, to judge from the language of her representatives in Parliament, is less satisfied with her position. The very fish, if we may credit some authorities, are deserting the coasts of this unhappy country; and Irish fishermen, with their old tackle worn out, and with no money to purchase new, are emigrating to other fishing grounds on the other side of the Atlantic. The picture annually presented to us of the miserable condition of Irish fishermen was so deplorable, that Parliament, last year, was induced to interfere. The Ministry was surprised by a hurried division, and unexpectedly defeated by a narrow majority. Its defeat compelled it to place a portion of the Irish Reproductive Fund at the disposal of the Irish Inspectors of Fisheries; and the Inspectors are now enabled to lend small sums of money to needy fishermen on their personal security. No such loan has yet been made. But, on the eve of adopting a new policy, it is occasionally desirable to review the circumstances which have led to it; and we turn, for this reason, to the recently published report of the Inspectors of Irish Fisheries.

The Report is divisible into two portions. The first and shorter portion refers to Sea Fisheries, Oyster Fisheries, and Harbours; the second and longer portion to the Inland or Salmon Fisheries. The salmon fisheries of Ireland are fairly prosperous. The amendments which are required in the law are not numerous or important; and we do not therefore propose to follow the Inspectors into their review of them. But the ten pages of the Report which are devoted to the sea fisheries and oyster fisheries of Ireland, deserve for every reason most attentive consideration. The oyster fisheries occupy a very short space in the Report, and may be dealt with in the first instance. The Inspectors have exercised almost absolute powers in dealing with this question. They are authorised to appropriate to any individual who applies to them, large portions of the fore shore of Ireland, and 130 licensed beds, occupying 18,825 acres of fore shore and sea-bottom, have thus been appropriated. The result of this wholesale appropriation of public dredging ground might well have justified Parliamentary interference. "The chief object," say the Inspectors, "in granting licenses (cultivation) has not been fulfilled. In the majority of cases we believe there has not been anything deserving to be called an attempt to cultivate the ground granted. The proprietors in numerous instances content themselves with getting as much as they can for their private use, and do nothing to replenish. We would be fully justified in cancelling the majority of the licenses." We quite agree with the Inspectors in this view; but we should like to know why some of the licenses have not already been cancelled. Two years ago the Inspectors assured us that they had "warned some licensees that their licenses will be withdrawn unless within twelve months they proceed to cultivate." The public have a right to inquire whether the warning has been attended to, and if not, why the threat of the Inspectors has not been carried out. The Inspectors, indeed, say that they have so "many pressing duties to perform," that they have been compelled to postpone attending to the oysters. But can any duty be more pressing than the restoration to the public of ground really taken from them under false pretences? The Inspectors have found time to grant five new licenses; they would have done much more to promote oyster culture if they had cancelled five old ones. "Overdredging and a succession of bad spatting years" are of course given as the cause of the growing scarcity. But it is worth while remarking that we had nothing of bad spatting years till overdredging had decreased the stock of oysters. If an oyster bed be scraped clean of all the adult oysters, no spatting season, however favourable, can be a good one.

But the most important portion of the present report is undoubtedly that which relates to the Irish Sea Fisheries. There can be no question about the decrease of Irish fishermen. In 1846, or before the famine, 113,073 men and boys were employed in 19,883 vessels and boats on this industry. In 1874 the number of vessels was reduced to 7,246! the number of hands to 26,924! The decline both in boats and men has been continuous throughout the period. But, with due deference to the Inspectors, it is easy to account for it. The "melancholy ocean" which surrounds Ireland is subject to very severe storms: and no fishing-boat can prosecute its industry consecutively throughout the year. Under such circumstances one of two things must happen—either the Irish Seas must be fished by men who, in strong weather, may resort to quieter fishing-grounds, or the Irish fisherman must combine other operations with his fishing. Before the famine the last of these things occurred. Every Irishman was a cottier. He tended his potatoes and his pig in bad weather: and he went a-fishing in calm weather. But, since the famine, the cottiers have gradually been worked out. Large farms have swallowed up small ones: and the occupiers of large farms, and their servants have no time to go out fishing. The class from which the mass of Irish fishermen were drawn had ceased, or is ceasing, to exist; and Irish fishermen are consequently decreasing in numbers. But, though Irish fishermen are decreasing, the Irish fisheries are not decaying. What do the Inspectors tell us? There were only 187 Irish boats engaged last year in the herring fishery off Howth. But there were 343 English, Scotch, and Manx boats. There were only 61 Irish boats in the mackerel fishery off Kinsale. But there were 226 English, Scotch, and Manx boats. The Englishmen, Scotchmen, and Manxmen, following the fish round the whole coasts of England, Scotland, and Ireland, beat the Irishmen, who never follow them at all. Every one has seen Cornish boats fishing for herrings in the North Sea; or Scotch boats beating the English in their own waters. But no one ever saw an Irish fishing-boat in either a Scotch or English sea. The Englishmen and Scotchmen, with their capital continuously employed throughout the year, beat, of course, the Irishman who leaves it idle and unemployed for three-fourths of it.

The view which we have thus expressed is not, however, shared either by the friends of Ireland or the Irish Inspectors. In their eyes the decrease in the number of Irish fishermen is equivalent to the decay of the Irish fisheries; and both of these are due to the unsympathetic attitude of this country. Last year nothing would do any good but loans. Now that the Reproductive Loan Fund has been utilised for this purpose with effects which we shall immediately notice, nothing will do any good but a safe and commodious harbour at Arklow. Such a harbour "is most necessary for the successful prosecution of both herring and oyster fisheries," and "unless something be done, there is little hope of any substantial improvement." We have no desire to discourage the construction of safe and commodious harbours, but we should like to ask the Irish Inspectors whether they ever heard of a place in England called Yarmouth. It is as important a fishing station as Arklow, it is on as stormy a shore; but when a storm is raging, the Yarmouth fishermen have to stand out to sea to avoid being driven on to the coast. We never heard that the want of a harbour at Yarmouth had destroyed the Yarmouth fishery; and we think that Yarmouth has at least as good a claim as Arklow for the construction of such a harbour. The new system of loans to fishermen remains for consideration. There has, of course, been no want of applicants for the loans. 2,800 individuals have already applied for the money, and we have no doubt there are a good many more quite prepared to follow their example. 1,300 of the 2,800 applications emanate from County Galway, and 160 of these applicants live in one parish. No more than six of the 160 "fulfil the conditions which should entitle them to obtain a loan!" We presume that as the Inspectors pointedly refer to the 160 applicants, they may be regarded as fair examples of the 2,800 who have applied. In that case only 105 persons throughout Ireland will, in the lenient judgment of the promoters of the policy, be entitled to participate in the loan. Is it possible to conceive a more striking illustration of the consequences of the policy?

MAGNUS'S "ELEMENTARY MECHANICS"

Lessons in Elementary Mechanics introductory to the Study of Physical Science, with numerous Exercises. By Philip Magnus, B.Sc., B.A. (Longmans, 1875.)

IN order to assign any work to its proper place it is necessary that we should try to ascertain what is the author's aim in writing it, and also to see if that aim be to any fair extent attained; further, we should take into our account the consideration of the question whether if the author's end be attained it is one worth arriving at. If the verdict on all these issues be favourable, then we may say that the *raison d'être* of the work is justified. For the aim of the present volume the title will suggest at once that the author does not attempt to produce a treatise which shall enter into comparison with such works as those produced by Thomson and Tait. Let us hear his own statement: "The lessons are intended for the use of those who have had no previous acquaintance with the subject;" and so he has endeavoured to bring into prominence the leading principles of Mechanics, and to exemplify them by simple illustrations. Here we may observe that the term mechanics is used in the ordinary acceptation of that word now-a-days, *i.e.*, as the science of the motion and equilibrium of bodies, and not in the Newtonian sense to which Messrs. Thomson and Tait seek again to restrict it. Starting on the hypothesis that the idea of Motion is more elementary than that of Force, since it is only from a combination of forces that equilibrium can result, the author makes the subject of Statics depend upon the laws of Dynamics. Hence the proposition, which is generally cited as that of the Parallelogram of Forces, Mr. Magnus derives at once from Newton's second Law.

After a short preliminary introduction we have "Kinematics—Motion" treated under the heads of Measurement of Motion and Falling Bodies; then "Dynamics—Force," under which heading we have Measurement of Force, the Laws of Motion, Energy, Machines.

The second part of the book discusses "Statics—Rest," under the following heads: Theory of Equilibrium, Centre of Gravity.

The style is lucid, the solved exercises carefully chosen, the work compact. With the exception above mentioned, of Statics being made dependent on Dynamics, the arrangement and matter are much the same as we find in English treatises. An intelligent boy ought in a few months to be able to make himself master of the greater portion of this small book, which Mr. Magnus has aimed at making sufficiently elementary to be placed in the hands of a beginner. What we consider to be higher praise is that we believe it to contain nothing that the student will have to unlearn in a subsequent portion of his career. We can recommend it as a trustworthy introduction to more advanced text-books.

We have endeavoured to test its accuracy as regards the answers to the numerous questions scattered over its pages. Of these there are 279 in the Dynamical portion, 192 in the Statical portion, besides 79 questions in an appendix composed of papers from the Matriculation, South Kensington, College of Preceptors, Oxford Local, Cambridge Local, and other Examinations. These answers seem to us to be exceptionally correct, as, though we have tried them all, we differ from Mr. Magnus's results in only a dozen cases; some of these cases are apparently clerical errors. We make this statement, taking into account two or three slips of errata which have been subsequently distributed by the author.

In Ex. 23, p. 86, 1·368th should be 1-368th, *i.e.*, $\frac{1}{368}$; § 199, we think, would not be easy for the pupil unless he had some aid from a tutor. Some of the questions given to the Matriculation candidates of the University of London seem to us hardly suitable for them; we shall select one, because even so experienced a teacher as the writer of the work we have noticed at first fell into an error. The question is: "Suppose that at the equator a straight, hollow tube were thrust vertically down towards the centre of the earth, and that a heavy body were dropped through the centre of such a tube. It would soon strike one side; find which, giving a reason for your reply." The author gives an answer which we have heard one or two "coaches" give also, but on a slip he has corrected his printed answer.

Again, in Ex. 27, p. 55: "A balloon has been ascending vertically at a uniform rate for 4·5 secs., and a stone let fall from it reaches the ground in 7 secs.; find the velocity of the balloon and the height from which the stone is let fall." Both Mr. Magnus and Dr. Wormell ("Natural Philosophy," p. 129, Ex. 45) work this question as if the balloon were at rest when the stone is let fall; we see no reason for their doing so in the wording of the question. They give the same height for the balloon, but differ in the velocity.

OUR BOOK SHELF

Game Preservers and Bird Preservers. By Capt. J. F. Morant. (Longmans, Green, and Co., 1875.)

To increase the annual rental of Scotch moorland, and to feel certain that at least thirty brace of grouse will fall to each gun after a whole day's sport, are the greatest delights of a certain few, according to whom every other consideration must be put in abeyance. Capt. Morant is one of these. "The red grouse is about the best game bird in the whole world, and deserves all the care we can bestow upon him." This care involves the annihilation of every creature that shows the least disposition to destroy and feed upon the eggs, young, or adult of *Lagopus scoticus;* and the death-list is no small one, including eagles, buzzards, hen harriers, all other Raptores, ravens, crows, magpies, wild foxes, polecats, stoats, and weasels. The stomachs of hawks are often found to contain the remains of weasels and rats; why kill them if they destroy those vermin? "If an alderman were shipwrecked on an uninhabited island, he would probably live upon the contents of a cask of biscuits which might be washed ashore. But the scientific gentleman among a party of savages who might examine him after his friends who happened to land on that island had killed him for their supper, would, we know, arrive at an erroneous conclusion if he entered it in his note-book as a fact that the animal *alderman* lived entirely on dry biscuit." This running analogy is the argument employed throughout the book, and it is this which makes it a particularly amusing one to glance through; whether it carries conviction with it is a different thing. The grouse disease is explained as depending on the fact that these birds, unlike others, eat only one food, heather, and when this is injured by cold or otherwise, they have no other to fall back on. That many shot-damaged birds survive and afterwards produce unhealthy offspring is considered unlikely. "Can we fancy a grouse telling his mate on a spring morning, My dear, I feel very poorly to-day; that No. 5 in my spine is troubling me dreadfully?" The author's raid against all the Raptores is very severe; he in this, as in other points, being much opposed to the general tenour of the report of the evidence given before the Parliamentary Select Committee appointed in 1873. His considerable experience adds great weight to the aspect of the question which he espouses.

The Handy-Book of Bees, being a Practical Treatise on their Profitable Management. By A. Pettigrew. Second Edition, revised and improved. (Edinburgh and London: Blackwood and Sons, 1875.)

A Manual of Bee-keeping. By John Hunter, Honorary Secretary of the British Bee-keepers' Association. (London: Hardwicke, 1875.)

THESE two volumes have different objects and will serve different purposes. The first edition of Mr. Pettigrew's book was favourably noticed in our columns five years ago (NATURE, vol. ii. p. 82), and we are glad to see that a second edition has been called for. Still more pleased are we to find that the author is open to conviction, and that he has acknowledged and corrected a few theoretical errors in the first edition. For the economical management of bees with a view to profit, there is no better guide than Mr. Pettigrew.

Mr. Hunter's volume, on the other hand, is essentially a book for the amateur, to whom profit is of less importance than the amusement and interest of bee-keeping. He gives an account of all the appliances of the modern apiarian, and of the most recent improvements in the treatment and study of bees. The various kinds of honey-extractors, feeders, guide-combs, and queen-cages; the methods of artificial swarming, queen-breeding, and ligurianising; the diseases and enemies of bees; and the various methods of preparing and preserving the honey and wax, are all briefly discussed. Some of the most recent observations on the habits and instincts of bees are given, including Sir John Lubbock's interesting proof that they distinguish colours. The book is illustrated with a number of useful woodcuts, chiefly of hives and apparatus; and it will be indispensable to amateurs who wish to acquaint themselves with the most recent improvements in the art of bee-keeping, and the latest discoveries as to the habits, instincts, and general natural history of the honey-bee. A. R. W.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Personal Equation in the Tabulation of Thermograms, &c.

IN a late number of NATURE (vol. xii. p. 101) you have commented upon the work performed by the Meteorological Office. Although in no way interested in the defence of that department, I think objection may fairly be taken to the style of criticism adopted. Not only would it, in most cases, be necessary to refer to the original thermograms satisfactorily to detect the many small errors pointed out, but it is well known to practical men that owing to certain idiosyncrasies of individuals some of the numbers 1, 2, 3 . . . 8, 9, 0 do occur in estimations more often than others, and of course more often than they should do theoretically. In no case are such personal peculiarities likely to show themselves more than in the determination of the position of a hazy photographic trace of sensible breadth, as between two sharply defined lines. As an example of my meaning, I may refer to somewhat similar estimations of tenths of seconds, as tabulated by the highly-trained and experienced observers of Greenwich, only premising for the information of the uninitiated, that the tenth part of a second is far too large a measure of time to be trifled with by astronomers, and that practically the estimation is simply that of the position of one sharply marked puncture or dot as referred to two others equally well defined on either side of it, indicating the beginning and end of the second, and separated by about one-third of an inch. Referring to the Greenwich Observations of 1864 (the only volume I have at hand), and taking three days' observations at random for the experiment, I have determined the percentage of times that each of the numbers 1, 2, 3...8, 9, 0 occur as the tenth at which transits of stars took place. As there is no theoretical reason why one number should predominate over another, we may expect that the percentage for each figure will be accurately 10, or each a tenth of the entire number.

The following are the percentages founded upon 511 estimations on April 21, upon 379 on April 19, and upon 393 on Nov. 5, 1864, respectively:—

	1.	2.	3.	4.	5.	6.	7.	8.	9.	0.
Percentages	5·7	6·5	9·0	21·1	11·7	11·0	6·3	8·4	5·9	14·3
	6·9	9·2	10·0	13·7	10·8	12·4	7·4	8·7	5·3	15·6
	8·4	8·1	7·6	13·7	10·9	9·4	8·1	9·7	8·9	15·0
Mean of 3 days	7·0	7·9	8·9	16·2	11·1	10 9	7·3	8·9	6·7	15.0

Although no one acquainted with the care bestowed upon this description of work at Greenwich would for one moment think of impugning the accuracy of these estimations, they show precisely the excess of whole seconds that is taken in the before-mentioned article as indisputably proving the carelessness of the tabulations at the Kew Observatory.

As regards these averages, it is to be remarked that with one slight exception all the numbers that are above or below the theoretical average in one example are above or below in all, and that there is only one case in which the range of difference exceeds 3 per cent. The partiality shown for the figures 0 and 4 is also most marked, and of itself would be enough to show that the same person had made all the estimations.

There is another light in which we may regard these results, which still more plainly indicates my meaning. The decimals ·1, ·2, &c., ought to include all possible positions of the puncture between ·05 and ·15, between ·15 and ·25, and so on; but according to the reader of the chronographic sheets, ·1 includes only those positions of the puncture between ·081 and ·151; ·2 includes those between ·151 and ·230; ·3 those between ·230 and ·319; ·4 those between ·319 and ·481, and so on. Thus the error of any single determination is very small indeed, a remark that will apply equally to the tabulations Meteorological Office.

To show that different observers have very different idiosyncrasies, I may append the following averages similarly determined, this time from the purely astronomical estimations of the time of transit of stars across the well-defined spider lines of the telescope by the method known as eye and ear observation, these estimations being made on a precisely similar principle. From the Greenwich observations of 1864 I find 206 such estimations by Mr. Dunkin, the standard observer at that time; 259 by Mr. Ellis; and lastly, 500 by myself in the present year, made at this observatory, yield the following:—

	1.	2.	3.	4.	5.	6.	7.	8.	9.	0.
D., 1864 ...	7·8	16·5	11·7	12·1	13·6	7·8	9·2	13·6	6·8	1·0
E., 1864 ...	5·4	8·5	7·7	9·7	8·5	11·2	12·4	13·5	12·4	10·8
P., 1875 ...	13·4	13·0	10·6	10·8	7·8	8·6	8·8	13·6	4·8	8·4

Although founded on rather too few estimations, there is little doubt that the salient features would be preserved in a more extended discussion. Thus D's avoidance of whole seconds and the adjacent numbers 1 and 9, E's avoidance of the former of these, and my own of the latter, may be expected confidently, however large a number of estimations are taken into account. The universal fondness for 8 is also noteworthy.

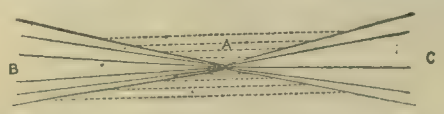
Orwell Park Observatory, near Ipswich JOHN J. PLUMMER

Source of Volcanic Energy

IN your report of the meeting of the Geological Society in NATURE, vol. xii. p. 79, I find notes of a communication submitted by the Rev. O. Fisher, F.G.S., on Mr. Mallet's theory of volcanic energy, and as I consider Mr. Mallet's paper to be one of surpassing value, I wish to make a few remarks on the criticism of it by Mr. Fisher. Mr. Fisher objects to the possibility of assuming high *local* temperatures to be produced by the transformation of tangential forces into heat, within the earth's crust.

If the strata of which the earth's crust is composed could be represented in a diagram by so many concentric circles of perfect regularity, the crushing force resulting from tangential pressures caused by the regular contraction of the mass would of course be equal all through the mass; but, as a matter of fact, such a diagram would not be a faithful representation of the lie of strata in the earth's crust. These strata occur at all sorts of angles, and are broken in upon by faults of great extent; so the pressures produced upon various parts of the earth's crust are far from equal. These inequalities are also increased by the differences in density of strata as also by the thinning out of strata of the same density.

For instance, a strain may occur somewhat in the manner of the annexed diagram. A set of strata may bear upon a point A, considering the forces to act in the direction BA, CA, and so cause the pressure upon a square foot at A to be a hundredfold greater than on a square foot at B. The work done, therefore, may not be equally distributed over certain areas; but forces may *converge* upon various points, and if the work is thus intensified in certain points, the heat developed in such points must be greater than where the forces are not so concentrated. It seems to me, then, that the rocks at A may be crushed to *fusing-point* by converging forces, while at the same time the rocks of the same set of strata at B may be at a much lower temperature.



If what I have attempted to point out contains no "untenable assumption," the possibility of the developed heat being localised remains intact; and this is certainly the main feature of Mr. Mallet's theory.

Mr. Fisher's objection to the primeval formation of our present existing ocean beds and continents seems a fair one, notwithstanding the fact of the remarkable steepness of the western coasts of all continents remarked upon by Mr. Mallet, but this remarkable similarity of formation may be no more remarkable than the fact of all the great promontories of the world pointing to the south and none to the north. Still, however, Mr. Mallet's paper may help us, for if the tangential pressures produced in the earth's crust be sufficient in some cases to produce long lines of volcanic activity, may they not in other cases be resolved into motions acting in various directions and causing the upheaval of continents and depression of ocean beds?

In conclusion I may remark that if *mere* cooling is not considered sufficient to account for the development of such forces, may not forces produced by gravitation acting in the very same direction be well acknowledged? Not mere gravitation of the surface upon a retreating nucleus, which of course is part of Mr. Mallet's theory, but gravitation of the *whole* mass to itself, which enormous source of energy must also express itself in tangential pressures in the more resisting crust of the earth?

Kenmare W. S. GREEN

Sanitary State of Bristol and Portsmouth

IN reference to the peculiar low mortality of some large towns in Great Britain, stated in the abstract of a communication to the Scottish Meteorological Society in NATURE, vol. xii. p. 281, as Portsmouth and Bristol, in contradistinction to others apparently in similar circumstances, having a high death-rate, I beg leave to point out that each of these towns is differentiated from the others mentioned in the paper in a *social* point of view more than in physical conditions. There is a large district in each of them, inhabited chiefly by visitors, tourists, retired professionals, and mercantile people, who take up their quarters in Southsea and Clifton, for the period of the regular seasons in each, or for limited tenure of occupation, either with reference to health, pleasure, or education of their families.

These divisions or quarters of Portsmouth and Bristol are under different physical conditions from the parent cities they are attached to, in that they are of separate growth, of later date of construction, better built, and inhabited by a wealthier class of people.

They might be compared to the apple-grafting on a crab-tree, on the old stem of which they flourish, but bear more showy flowers and more luxuriant fruit, and they thus tend to ameliorate the inherent deficiencies of the original tree by adding a higher and more cultivated life.

Topographically speaking, again, these two districts are entirely different from each other, though equally healthy, as above stated, Southsea being built upon a plain near the sea, and Clifton being built upon a hill above a river: the one lies on gravel and the other on limestone, so that these and other material circumstances, oddly enough, can scarcely be thought likely to produce a common result on their sanitary state.

The original towns of Portsmouth and Bristol, however, are nearly alike in some points, but not in others. Both are shipping ports, both are on tidal harbours, both are built along the banks on each side, and are therefore low in altitude above the sea; but the former lies on gravel, while the latter is built on alluvium and red sandstone. Most other large towns are of a homogeneous constitution, as Manchester in manufactures, Liverpool in shipping, Scarborough as a seaside resort, and Cheltenham as an inland watering-place; but Portsmouth and Bristol are peculiar in having this double social composition of a shipping port and a health-resort in one borough, and which, therefore, might be taken into account in any deductions from statistics of health or mortality of their united populations.

British Association, Bristol W. J. BLACK

A Lunar Rainbow?

THERE can be little doubt that your Australian correspondent, Mr. Lefroy (vol. xii. p. 329), has seen one of the phases of an Aurora Australis. Similar appearances have been observed by me in Scotland, passing south of the zenith (and nearly through the anti-dip, as at Fremantle). Their sudden occurrence and temporary persistence are perplexing to those who have not seen this particular display before. The first seen by myself (in 1844, I think) was a single beam which remained in the same position during some hours; it was described by me next day in a local paper, while a well-known observer in a communication to an Edinburgh journal had taken it for a comet.

It is pleasant to see accounts of such phenomena sent to NATURE from all parts of the world, even when the true cause has not always been apparent. It is not improbable that the magnets at Melbourne will have shown some slight disturbance about 8h. 30m. P.M. of May 16.

JOHN ALLEN BROUN

I DO not see any reason to doubt that the phenomenon seen by "J. W. N. L." in Australia, and described by him in vol. xii. p. 329, was an aurora. I never saw one with so many arches as he mentions (eighteen or twenty), but there can be no reason for supposing so large a number to be impossible. In almost every other respect his description agrees exactly with auroras such as may occasionally be seen. T. W. BACKHOUSE

West Hendon House, Sunderland, Sept. 4

The House-Fly

I WAS somewhat interested in Mr. Cole's remarks on the house-fly in NATURE (vol. xii. p. 187), and recently had an example of another of its enemies. On touching a rather small decrepit house-fly which was making its way across a sheet of paper, three minute, active animals, apparently beetles, tumbled out of it; they were light brown in colour, and very much the shape of *aphides*, and about the size of the hole a medium sized pin would make when pushed through paper. F. P.

OUR ASTRONOMICAL COLUMN

M. LEVERRIER'S THEORY OF SATURN.—Early in the year 1874, M. Leverrier presented to the Paris Academy of Sciences the conclusions he had drawn from the comparison of his analytical theory of the planet Jupiter with the meridian observations made at Greenwich and Paris during the long period of 120 years, which he found to be represented thereby with all desirable precision; thus proving that the motion of Jupiter is not subject to any sensible action beyond the effects of the known planets.

The comparison of the theory of Saturn with a similar extended course of normal positions, each one based upon a great number of observations, has not run quite so smoothly, but, on the contrary, has presented some slight difficulties, upon which M. Leverrier makes known his opinion, in a communication to the Paris Academy on the 23rd of last month. During the thirty-two years of modern observations, 1837-69, the differences between theory and calculation, except in two instances, remain below 0·2s. in the times of passage observed on the meridian; for the older observations of Maskelyne and Bradley, somewhat larger discordances are shown. The residuals are, however, upon the whole, very small, and a question arises, whether such quantities can be legitimately neglected, or, if not, whether their cause is to be sought in incompleteness of the analysis or in errors of the observations themselves. M. Leverrier has not been content to rest upon the first supposition, but states that he has used every effort to elucidate the source of the remaining differences. To satisfy himself and astronomers generally that there is no defect or inaccuracy of theory, M. Leverrier has taken extraordinary pains to guard against error or omission. When he found in his earlier researches a discordance between theory and observation in the case of Mercury, he was able to explain the whole by admitting an increase in the motion of the perihelion, which might be attributed to the existence of cosmical matter or the action of small bodies nearer to the sun than the planet; and again, when the comparison of theory with the observations of Mars showed differences, they were explainable by a similar assumption of increased motion of the perihelion, necessitating an increase in the mass of the earth, and consequently of the solar parallax. In the case of Saturn, the smallness of the residuals has rendered it a much more difficult matter to pronounce with confidence upon their cause. Having reviewed the whole of his analytical theory, M. Leverrier, with the view to further verify it, considering this theory as a first, though exact approximation, proceeded by methods of interpolation to reconstruct it, taking account at once of the terms of all orders. Every possible verification having been thus accumulated, he concluded that no error was to be apprehended in this direction. The comparison with the normal positions having been certified with equal care, he ascertained the effect of small changes in the masses of Jupiter and Uranus, the errors being exhibited in functions of the corrections to these masses, and the results prove that no alteration in the adopted value of either mass will destroy the residuals as a whole; if they are somewhat diminished thereby in one part of the series, it is only at the expense of increasing them in other parts. Indeed, M. Leverrier establishes one point, and a very remarkable one it will no doubt be considered, viz., that the 120 years of meridian observations of Saturn are insufficient to afford a reliable value of the mass of Jupiter; or, in other words, that the mass of Jupiter which has so great an importance in the elements of the solar system, is not yet determinable from the comparison of the theory of Saturn with observations. This was not the case as regards the mass of Saturn, which M. Leverrier found from his researches upon the motion of Jupiter to be $\frac{1}{3529 \cdot 56}$ a somewhat smaller value than that resulting from Bessel's measures of the Huygenian satellite.

Under the above circumstances, the probability that errors of observation are the cause of the remaining differences from theory is much increased, and M. Leverrier appears inclined to attribute these errors to the interference of the rings under their various phases, an explanation which practical men will assuredly regard with favour. Considering that at certain times the rings disappear entirely, when the planet's centre may be well observed, while at others intervening in an elliptical form, projecting shadows and occasionally rendering impossible the observation of one of the limbs, there is nothing unlikely, as M. Leverrier remarks, in an uncertainty of some tenths of a second in R.A., which would sufficiently explain all. At any rate, whatever influence the interference of the rings may have upon the observations, it is doubtless of a variable character, as well on account of the physical fact itself, as from the effect it may exercise on personal equations.

MR. DE LA RUE'S TABLES FOR REDUCTION OF SOLAR OBSERVATIONS.—"Auxiliary Tables for determining the angles of position of the Sun's Axis and the Latitude and Longitude of the Earth referred to the Sun's equator," which have been employed in the reduction of the ten-year series of solar photograms taken at the Kew Observatory, have just been printed by Mr. De la Rue, professedly for private circulation, though, as they have been imposed in the size and type of the "Philosophical Transactions," it may possibly be the author's intention to append them to a future communication to the Royal Society, in continuation of other important papers already published in the "Transactions,"—a place which the Tables will advantageously occupy. They give with sun's longitude as argument, the inclination of the solar axis to the circle of declination, reckoned positive when the axis is west of the north point of the sun's disc, and assuming the inclination of his equator to the ecliptic to be 7° 15′·0, and the longitude of its ascending node $74^\circ - \nu$; and with argument, sun's longitude $+ \nu$, the "Heliographical latitude of the earth" and "Reduction of longitude." The obliquity of the ecliptic is taken, 23° 27′·5, but to correct the angle between the circle of declination and the sun's axis, for difference of true and assumed obliquity, a supplementary table is provided.

The Tables have been calculated by Mr. Marth, and it will be obvious to anyone initiated in such work, that considerable trouble has been taken to ensure their accurate production.

MIRA CETI.—A *minimum* of this variable star is set down in Schönfeld's ephemeris for September 30. The minima have not been properly observed nearly so often as the maxima, though equally important in the investigation of the laws which regulate the fluctuations of light, and which, according to Argelander's researches, involve a more complicated formula than has yet been deduced for any other variable. The circumstances of the approaching minimum are very favourable for observation.

SCIENCE IN GERMANY

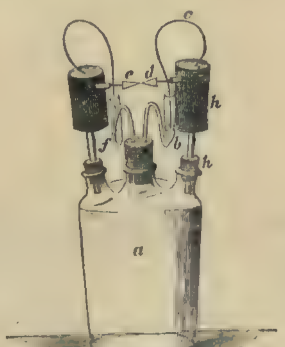
(*From a German Correspondent.*)

ONLY for a small number of elements and their compounds is the relatively low temperature of the non-luminous gas flame sufficient to produce spectra which can be of use in analytical researches; by far the larger number turn into vapour at such degrees of temperature as we can obtain solely by the electric spark. We are therefore confined to spark spectra fór such bodies which do not give spectra in the flame, and these spark spectra can all the less be dispensed with in those cases where *new* elements are sought for, or where it is a question of proving beyond all doubt the presence of certain bodies, which in their chemical properties are so much alike that ordinary reagents do not suffice for their discovery or separation.

But there are difficulties in the way of practically using spark spectra, which have been the reason why these important means of reaction have not yet found their entry into all chemical laboratories. First of all, a simple method has been wanting by which spark spectra can be obtained at any time. Whoever has been obliged to use currents of great intensity with temporary interruptions of days, weeks, or months, knows how much unpleasantness is caused by fitting, taking to pieces, and cleaning the ordinary constant batteries used hitherto. Another difficulty lies in the fact that spectrum tables are still wanting which would be of sufficient service for all practical purposes. It is true that a large quantity of measurements have been published, and doubtless some of them are extremely accurate, but with the greatest part of them the purity of the substances experimented with is not in the least guaranteed, and very often it can be proved not to have been attended to at all. If it is attempted to reduce to a universal scale all the spectrum drawings at hand which have been obtained by different observers, with different refractive media, with different widths of the slit, some at a higher, and some at a lower temperature, tables are obtained which are completely and utterly useless in the laboratory.

Lately Prof. Bunsen, of Heidelberg, has tried to remove all these difficulties. In a very important treatise, the first part of which has just been published, he first describes a new battery and a new spark apparatus, by means of which spark spectra can at any time be obtained with the same ease and facility as ordinary flame spectra. The battery is the charcoal-zinc battery without clay cells. The exciting liquid is a mixture of bichromate of potash and sulphuric acid. In order to prepare 10 litres of this liquid, Prof. Bunsen gives the following instructions:—0·765 kilogrammes of commercial powdered bichromate of potash, which as a rule contains about 3 per cent. of impurities, are mixed with 0·832 litres of sulphuric acid in a stone jar while the mass is being constantly stirred; when the salt is changed to sulphate of potash and chromic acid, 9·2 litres of water are added, the stirring being kept up and the water allowed to flow from a spout about ½ inch wide; the crystal meal, which already is very warm, thus gets warmer and warmer and eventually dissolves completely. The exciters for this liquid are: a rod of the *densest* gas coal, 4 cm. broad, 1·3 cm. thick, and immersed 12 cm. deep into the liquid, and a rolled plate of zinc 4 cm. broad, 0·5 cm. thick, and immersed to the same depth as the coal; the zinc plate is entirely coated with a layer of wax (which is put on whilst hot), except that plane which is turned towards the coal and which is amalgamated. The distance between coal and zinc is entirely optional; in the spectral and analytical researches of Prof. Bunsen it varied according to circumstances between 3 and 10 millimetres. The results with this battery are, however, not very satisfactory with regard to duration and constancy of current, if the cell containing the exciting liquid is made of the same size and shape as those in the ordinary Grove or Bunsen battery. The reason of this lies in the circumstance that in the nitric acid of those batteries there is far more oxygen contained, which is employed for depolarisation, than in an equal weight of the chromate liquid, and that therefore a comparatively much larger quantity of the latter is used up to obtain the same effect. The chromic acid battery therefore, compared to Grove's battery, requires cells of at least three to four times more capacity. The best shape for these cells is that of narrow, high cylinders. The column of liquid, of about 1·6 litres, has a diameter of about 0·088 metres, and stands 0·28 metres high in the cylinder, which bears a mark at that height. The zinc-coal pair is only immersed up to half its height into the liquid column, and has an active zinc surface of about forty-eight square cm.

With regard to the constants of this chromic acid battery *without* clay cells, it considerably surpasses in electromotive force all other apparatus *with* clay cells hitherto used. It possesses an electromotive force which is about 13 per cent. larger than the ordinary charcoal-zinc or Grove battery. Its essential conduction resistance is about 12 per cent. smaller than that of Grove's battery with clay cells. In order to be able to judge the economical effect of the chromic acid battery, we will consider a little more in detail the chemical processes taking place in this battery. In unconnected freshly filled Grove batteries the consumption of zinc is very small, only when after prolonged use an electrolytic and endosmotic exchange has taken place between the two exciting liquids, a consumption of zinc, independent of the generation of the current, becomes apparent. In the unconnected chromic acid battery, however, the consumption of zinc at the very beginning is entirely the same as that which is observed in connected batteries during the generation of the current. This circumstance makes it indispensable to arrange the chromic acid battery in such a manner as to make it easy, at every interruption of the current, to bring the exciting plates out of contact with the liquid. This is attained by a simple hand lever arrangement by which the plates can be dipped into or raised out of the liquid. It is of particular interest, not only for practical purposes, but also from a theoretic point of view, to compare the consumption of zinc during the generation of the current with that in the unconnected battery, as theory alone gives no basis on which to decide the question whether the zinc disssolved in the unconnected battery is entirely, partly, or not at all used in the connected battery for the generation of the current. Investigation showed that the quantity of zinc dissolved in the disconnected battery is a little under half of the consumption of zinc necessary acording to theory to generate the current in the connected battery, and that only a part of the metal dissolved in the disconnected battery without current-generation is used up in the connected one for the generation of the current. This fact entirely corresponds with the view that the dissolution of the zinc must not be looked upon as the cause of the current, but as a necessary condition of the same. Investigation further showed that while in the chromic acid battery above described, on the average only 22 per cent. of zinc was lost, the loss in the nitric acid battery experimented with was 48 per cent. on the average. The chromic acid battery without clay cells is the least constant one amongst the ordinary constant batteries. But if used in a proper manner it may serve for a very long time. Prof. Bunsen possesses a battery of this kind, of forty pairs, with an active zinc surface on each plate of only forty square cm. For the last eight lecture-terms it has served for all experiments without its having been necessary during this long time to renew the zinc plates, or their coatings of wax, or the original exciting liquid, nor to clean the conducting connection parts; it has been merely necessary to renew now and then the amalgamation of the zinc plates (an operation which only takes a few minutes of time) and to replace that part of the liquid which was lost by evaporation in the air, by simply filling the cylinders with water up to the marks on their sides. The apparatus to this day still gives an electric arc between carbon points which amply suffices for the photo-chemical lecture experiments. The currents obtained by this battery, which has now been in use for already more than four years, are still powerful enough for demonstrations in electrolysis, spark spectra, decomposition of gases by induction sparks, &c., and will doubtless continue to suffice for all these purposes for some time to come. But we must again repeat that effects of such magnitude can only be expected if the precaution is used (and it is very easy to do so) not to leave the pairs in contact with the liquid for one moment longer than the duration of the current necessary for the experiments requires it.



The battery used for the production of spark spectra consists of four of the pairs above described. The pole wires conduct the primary current, of which a branch puts the current interruptor into action, to a Ruhmkorff apparatus, the induction coil of which has a diameter of nearly 0·2 metres and a length of 0·5 metres. The current induced in the same is conducted to the spark apparatus, standing in front of the slit of the spectroscope: *a*, a bottle with three necks, serves as a stand for the spark apparatus. The induced current goes from the mercury cup *b*, through the fine wire *c* to the carbon point *d*, which is fastened on a pointed platinum wire; thence it passes as a spark to the other carbon point *e*, and from this it reaches the second mercury cup *f*, which is connected with the other end of the induction coil. The platinum wires, which are surrounded by glass tubes sealed firmly upon them, can be moved upwards or downwards by the corks *h*, and this allows of a quick and exact fixing of the carbon points before the slit of the spectroscope.

The carbon points destined to receive the little quantities of liquids under examination are best prepared from the ordinary and not too light drawing charcoal, which is easily procurable. In order first to impart conducting power to the charcoal, a great number of the sticks are exposed to the most intense white heat for some time in a covered porcelain crucible, which stands in a larger clay crucible, and is on all sides surrounded by charcoal powder. Then the sticks are cut to points at one end, and the little charcoal cone thus obtained is cut off with a fine watchmaker's saw. In order to remove the silica, magnesia, manganese, iron, potash, soda, and lithia which the charcoal contains, about a thous and of the points are boiled in a platinum dish, first with hydrofluoric acid, then with concentrated sulphuric acid, then with concentrated nitric acid, and finally with hydrochloric acid, repeating each process several times, while between each manipulation each of the acids is removed by washing and boiling with water. After this treatment the carbon points are ready for use. A carbon cone of this description weighs about 0·015 grammes, and can absorb more than its own weight of liquid. The spark spectra obtained by aid of them are of very long duration.

We will report on the second part of Prof. Bunsen's treatise as soon as it has been published. W.

HISTORICAL NOTE ON THE OBSERVATION OF THE CORONA AND RED PROMINENCES OF THE SUN*

SO much interest attaches to the phenomena of the corona and red prominences, as observed during total solar eclipses, and correct views of their nature and of the proper means of observing them are so recent, that I feel it proper to give here a brief account of what I believe to be the first attempt to see these, under ordinary conditions, with an uneclipsed sun.† This account is contained in the private diary of the late G. P. Bond, formerly director of the Observatory of Harvard College, which has become known to me through the kindness of his daughters.

Bond observed the total solar eclipse of July 28, 1851, at Lilla Edet in Sweden, and his report is published in the Memoirs of the Royal Astronomical Society, vol. xxi., p. 97.

From Sweden, Bond went to Geneva, where he arrived in September 1851, and from this point I may transcribe from his diary, making no changes except the occasional insertion or omission of unimportant words.

"*Geneva, Sunday, Sept.* 14, 1851.—I think I must go to Chamounix to try whether it may be possible to discern the red flames on the sun's disc by occulting all but the very edge, upon one of the lofty peaks. It seems to me not altogether impossible. Certainly an experiment worth trying and a new application of the '*Aiguilles*.' . . .

"*Geneva, Sept.* 15, 1851.— . . . The weather looks dark and lowering, with an uncomfortable north-east wind, but M. Plantamour thinks it is likely to be fine weather, and on this recommendation I took a place in the diligence for Chamounix. . . .

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* By Edward S. Holden. Reprinted from the August number of the *American Journal of Science*.

† Airy, Nasmyth, Baden-Powell, Piazzi-Smyth, and others experimented in this direction, about this time, with various results. See Edinburgh Ast. Obs., vol. xi. p, 279; Mem. R. A. S., vol. xvi. p. 301, &c.

"*Chamounix, Sept.* 18, 1851.—Last evening the stars were shining through the opening clouds, giving promise of improving weather, but a glance out of the window this morning dispels all such anticipations. . . .

"*Chamounix, Sept.* 19, 1851.—I woke this morning at five, and my first impulse was to go to the window to see the signs of the weather. Last night I had hopes of an improvement. But I was surprised to find a clear sky; some clouds were resting round the *aiguille*, but the summit of Mont Blanc was clear. Started for Montanvert at 7.15 with a guide. . . .

"*Mer de Glace.*— . . . Attempted two or three times to hide the sun's disc by projecting rocks to try to see the red prominences, but could not get a station far enough off. . . .

"*Chamounix, Sept.* 20, 1851.—Snowing fast in morning. Weather desperately bad. But before going to bed it was quite clear. . . .

"*Chamounix, Sept.* 21, 1851.— . . . The fine prospects of last night were effectually put aside by another snowstorm. . . .

Chamounix, Sept. 22, 1851.—The morning bad as usual. . . .

Chamounix, Sept. 23, 1851.—This morning still cloudy, yet the prospect for an improvement was encouraging. Soon after breakfast the sun appeared struggling in the clouds, and I hurried off with a spy-glass not to lose the slightest chance of seeing the phenomena I wished to. . . . I spent two or three hours in the wet fields to no purpose. In the afternoon there was an effort at clearing again.

"*Chamounix to Martigny, Sept.* 24, 1851.—The clouds this morning still hung on the mountains, but overhead there seemed some signs of clear sky. To make sure of losing no chance I took an early breakfast and left for the fields with the ordinary spy-glass belonging to the hotel under my arm. Sometimes it would be almost clear, and then again it began to rain, and I was undecided whether to give up and start for Martigny or to stay another day. At last I saw the sun's disc and took up my station on the edge of the shadow of the *Aiguille de Blettière.* It was still cloudy, but I was satisfied from the nature of the experiment—

"1st. That a very clear air is necessary.

"2nd. Plenty of time to choose projections, affording views of as large a portion of the circumference of the disc as possible while the rest is hidden.

"And lastly, a good achromatic telescope easily moved.

"I did not expect to find it so easy an experiment, nor to find a mass so well fitted for the purpose as the *Aiguille de Blettière*, which has a smooth edge, inclined, so as to allow the sun to disappear slowly behind it,

"The naked eye easily bears a small portion of the sunlight. From 7 to 9½ I followed the shadow over the valley. It was nearly clear for a few moments before it reached the woods on the side of the mountain, but there were still some light clouds over the sun, and nothing could be seen certainly of the corona; the clouds and mist would account for what I did see, and on the other hand the colour of the telescope supplied too much red just at the edge for one to be able to see any of the red flames, if they existed there.

"On the whole, I am more than ever sure that the experiment can be made, and I think will be by some one more fortunate than I."

SOLAR OBSERVATION IN INDIA

NOW that the subject of solar observation in India is likely to occupy the attention of the scientific public, he following details of the Solar Observatory now in progress of construction at Calcutta may be of interest to readers of NATURE.

The suggestion emanated in the first place from the well-known Italian astronomer and spectroscopist, Prof. Tacchini, who was sent to India by the Italian Government as director of the Transit of Venus Expedition. The idea thus put forth was at once taken up by Père Lafont, the principal of St. Xavier's College. A subscription was opened to enable the work to be carried on, and in a short time the collections had amounted to 10,000 rupees, to which the Indian Government added 5,000 rupees. So warmly does the idea seem to have been taken up, that a theatrical benefit was given, at the suggestion of Col. Wyndham, in aid of the Observatory fund.

The observations proposed to be carried out are to supplement those made in Italy, where from November to March (inclusive) the sky is often unfavourable for observation. A complete annual record of changes in the sun's chromosphere, &c., will thus be kept up. With regard to instruments, an equatorial of 7-inch aperture is now being constructed by Merz, but more funds are needed to complete the instrumental "plant" of the Observatory. In course of time it is to be hoped that a transit instrument and a complete set of meteorological apparatus will be added.

The Italian Transit of Venus Expedition has thus been the means of sowing seeds which, finding themselves in a soil most favourable for development, are calculated at no very distant period to bear fruit of the greatest value to science. When in Calcutta with the Royal Society's Eclipse Expedition, last April, I visited the Observatory in company with Prof. Tacchini, and the work of construction was then in a very advanced state. Prof. Tacchini has recently written to say that the building is now almost completed.

The energy which has been displayed in connection with the Calcutta Observatory[*] redounds greatly to the credit of our Indian colleagues. It is only by systematic observations of this kind, carried on by public enterprise, that we can ever hope to detect cyclical changes in the sun's composition and constitution—changes which, taking enormous periods for their completion, may demand continuous records to be carried on even through many generations.

R. MELDOLA

THE LAWS OF STORMS[†]

M. FAYE, in the article referred to below, and of which we propose to give an abstract at considerable length, begins by referring to the stupendous force of tropical tempests as contrasted with those of Europe, and to the practical importance of knowing the laws which regulate them. Many persons, he believes, on reading the title of his paper, will be surprised to learn that hurricanes have laws, or will ask what an author means by proposing to expound and vindicate the Law of Storms.

Laws of Storms.—Not only are storms subject to laws of great interest to science, but from these laws practical rules may be deduced which will enable us to avoid these dangers, or escape from them, should we happen to be caught in a storm. These rules are taught in all naval schools, and are the foundation of the sailor's safety. The validity of the laws on which they are based has, however, been disputed by some writers on Meteorology, and therefore the Bureau des Longitudes has authorised the publication of M. Faye's paper, in which he attempts clearly to expound and to defend the disputed laws.

Referring to the valuable labours of Piddington in India and Redfield in the United States, and of Reid, M. Faye says that the only premises they had to start from were the idea that there ought to be something regular in the progress of hurricanes, and the observed fact that in every disastrous storm the wind appeared to move in a circle. They said to themselves: "We do not seek to know how storms are formed, but how they progress." Instead of speculating, as did former meteorologists, on storms of aspiration, on the rôle of electricity, on the conflict of opposing currents, &c., they collected for each tempest extracts from the log-books of all the ships which had been involved in it. After having abstracted and arranged this immense quantity of material, they marked upon a chart, at certain dates, the positions of these ships and the direction of the winds observed. Then, by placing on this chart, after several trials, a series of tissue-papers on which had been drawn concentric circles, they made sure that the wind-arrows at the same instant closely coincided with these circles, so that at that very instant, over all the region subjected to the storm, the mass of air resting on the ground or on the sea must have been acted on by a vast gyrating movement around a centre. Some idea of the nature of these researches will be obtained from Fig. 1, which shows a very small part of the chart of the hurricane which ravaged the island of Cuba in 1844. Redfield collected sufficient information to determine the figure of the hurricane at twenty-five different times, between Oct. 4 and 7; the figure shows two of these. The same phenomenon was reproduced at all the other times; everywhere the hurricane assumed this strikingly circular form.

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[*] The Observatory is situated in St. Xavier's College, Park Street, Calcutta.

[†] Abstract of a paper, "Défense de la Loi des Tempêtes, par M. Faye, Membre de l'Institut," in the *Annuaire* of the Bureau des Longitudes for 1875.

All tornadoes, typhoons, hurricanes, present the same character wherever they occur, and they preserve it throughout the entire duration, and over all their area, which often extends to more than 600 leagues. The conclusion is evident; there is evidence here of a vast rotatory movement, definitively confined to one portion of our atmosphere, which is at the same time subjected to a movement of translation.

It is remarkable that when all the separate results obtained over the whole of the northern hemisphere are compared, it is seen that the gyration takes place always and everywhere from right to left, in a direction opposite to that of the hands of a watch (see Fig. 1). Still more remarkable is it that over all the southern hemisphere the same law, the same gyration is found, but in a direction opposite to that of the preceding, from left to right, *i.e.*, the same direction as that of the hands of a watch. There is here evidently one law, and that a law without exception; these terrible gyratory movements turn constantly to the left in the northern hemisphere, to the right in the southern hemisphere.

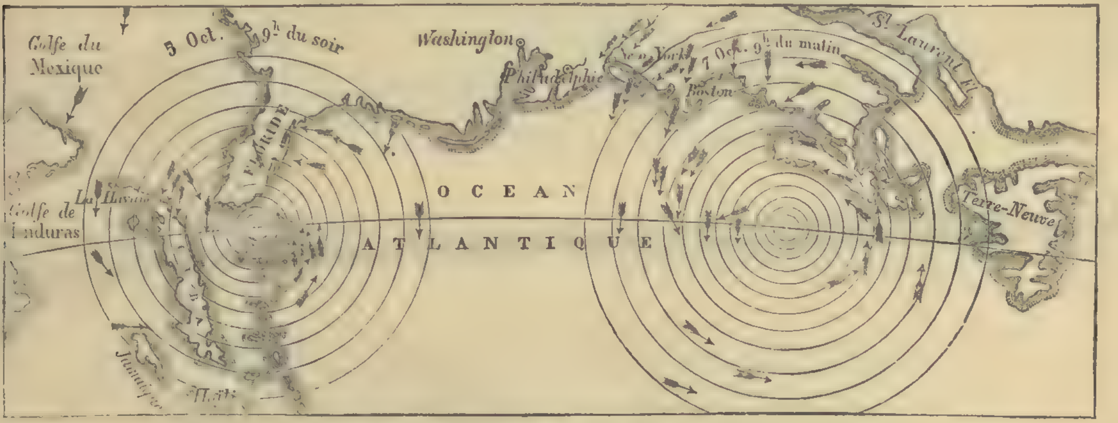


FIG. 1.—Hurricane at Cuba from Oct. 5 to 7, 1844.

Finally, the trajectories present some very striking common characteristics in each hemisphere, and in both hemispheres a remarkable symmetry. The lines tracked by the centres of these cyclones do not descend directly from the equator to either pole; on the contrary, they incline first to the west, then, after having passed the limit of the trade-winds, they bend towards the east, in a final direction roughly perpendicular to the former. Fig. 2 will enable the reader to follow in the two hemispheres the development of cyclones. Originating not far from the zone of calms or of variable winds, on both sides of the equatorial zone, they measure scarcely more than two or three degrees at the outset, but as they proceed towards higher latitudes their area gradually enlarges. In the two temperate zones they attain a diameter of more than ten degrees, and frequently occupy upon the terrestrial globe a space considerably larger than that of France.

Thus all is symmetrical on each side of the equator, or rather of the zone of calms, which oscillates a little each year with the course of the sun. There is symmetry in the direction of rotation, symmetry in the direction of progressive motion, general symmetry in the figure of all these trajectories; and this holds good all over the globe.

Such are the storm laws, the discovery of which is mainly due to England and the United States, "the two greatest maritime powers of the world." The product purely of observation, of empiricism, to use that word in its highest sense, they have not yet reached the stage of theory. On the contrary, in order to discover these laws, it has been necessary to cast aside contemporary prejudices and doctrines, the deadening influence of which we have hourly opportunities of witnessing.

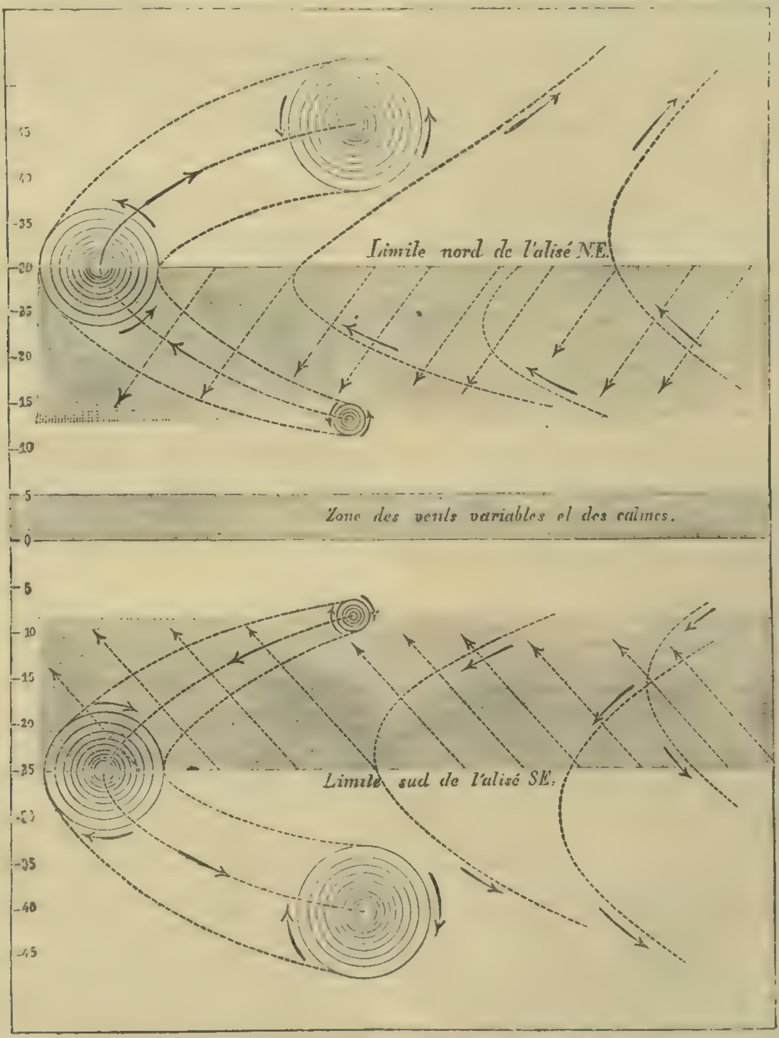
Practical Rules.—But the practical object of these investigations is to save human life. Do we know of no premonitory signs? After the cyclone has commenced, have we any means of discovering the direction of the centre where the rotation is accelerated, where all the sources of danger are accumulated? How can we find out the direction of its march? How learn whether a ship is caught in the dangerous region, where the rate of the wind is the sum of the rates of rotation and of progress; or in the moderate region, where the rate of the wind is only the difference? Finally, what manœuvres are necessary in order to avoid the tornado or to escape from it if by mischance we should be caught in it?

To all these questions there are answers, some exact, imperative as are the exigencies of the danger; others more elastic, leaving room for tact and ability on the par of a commander.

By a fall continuous and prolonged, the barometer, which is never at fault in the tropics, announces that a cyclone is at a distance. As soon as the wind blows with a certain force, it is easy to determine the direction in which the centre of the cyclone will be found. The following is Piddington's rule:—Turn the face to the wind and stretch out the right arm; the centre is in this direction. The left arm must be used when a ship is in the southern seas. Soon the wind increases, and the fall of the barometer becomes more rapid; the centre is getting nearer, for the cyclone has an onward motion. If the wind continues to increase without changing direction, you are in the very path of the centre, and soon you will be in the very heart of the tempest. Then suddenly a calm ensues; at the centre of the cyclone exists a circular space where a relative calm prevails. There the sky reassuming its serenity, the sailor might be led to believe himself safe; but this space is soon passed, and immediately the tempest recommences. Only the wind has suddenly jumped round 180 degrees; it blows now in the direction opposite to the previous one, at right angles to the trajectory of the centre of the cyclone.

The situation which we have just supposed is a peculiar case; in general the vessel will be found to the right or the left of this trajectory, whose direction, moreover, an attempt must be made to determine.* The alternative is far from being a matter of indifference; it is a question of life or death, for the one corresponds to the favourable semicircle, the other to the dangerous. The following is Reid's rule, which eliminates all uncertainty:—In whatever hemisphere, if the wind changes direction successively by turning in the same direction as the cyclone itself, the favourable semicircle is indicated; if the wind changes by turning in the direction opposite to that of the proper rotation of the cyclone, the dangerous semicircle is indicated.

FIG. 2.—Hurricanes of the northern hemisphere (July to October).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Limite nord de l'alisé N.E.
Zone des vents variables et des calmes.
Limite sud de l'alisé SE.

Hurricanes of the southern hemisphere (January to April).

This may be accounted for by examining Fig. 3. The observer, supposed to be immovable, has his face turned towards the series of winds which will strike him successively as the cyclone passes over him.

In the favourable semicircle (southern hemisphere), if the ship behaves well in a rough sea, it is possible to avoid the centre and the cyclone itself by the shortest way, perpendicularly to its trajectory. The storm is always formidable, but it is manageable. If, however, the violence of the wind, the state of the sea, and the weakness of the ship should make flight impossible, there should be no hesitation in putting about ship and bringing to on the starboard tack (the wind on the right side). The vessel appears then to make for the centre of the hurricane, but it makes no headway; it thus escapes being covered by the wind, and there is no risk of being struck by seas behind, inevitable consequences of a port tack. Soon the hurricane disappears by its motion of translation, good weather reappears, and at last sail may be made.

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* We do not dwell on this last point, which can only be solved by skilfully comparing the indications of the barometer with those of the direction and force of the winds.

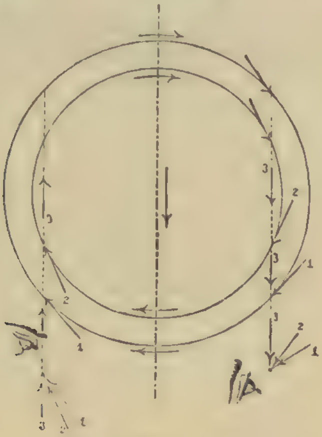

FIG. 3.

(*To be continued.*)

THE BRITISH ASSOCIATION

THE second *soirée* was very interesting, although not remarkable for novelties. The Post Office Telegraphic staff appeared in force, showing all varieties of method and apparatus. A splendid series of Geissler vacuum tubes was exhibited by Mr. F. J. Fry. Sir W. Thomson's tide-gauge and tide-calculator, the apparatus for deep-sea sounding, models of railway signals, means of communication between passengers and guard, and Dr. Leitner's collections from Dardistan were among the most attractive objects.

The concluding general meeting presented no remarkable feature, and called forth no very notable speeches. Among the papers to be printed in full in the Report is that of Prof. Cayley, on the application of mathematical trees to chemical theory. The local committee and officials were thanked most heartily and deservedly. They have had the best intentions, adequate means, and good plans, and have employed the energy needed for the fruition of their ideas. The actual number of members, associates, and ladies present during the meeting was 2,249, the number having been somewhat swelled by late arrivals.

The vote of thanks to the President, moved by Sir W. Thomson and seconded by Dr. Carpenter, was not merely formal. Sir W. Thomson eulogised Sir John Hawkshaw as a man who believed that good practice proceeded from good theory. Certainly the President's tone of mind seems to have influenced the work and proceedings of the meeting, for it has been on the whole quiet and genial, yet busy and important in useful results obtained by the scientific employment of common sense, if not of imagination. Thus ended the formal proceedings of a meeting in which three Sections had to sit up to the latest moment in order to get through their work.

The following is the list of grants of money appropriated to scientific purposes. The names of the members who would be entitled to call on the general treasurer for the respective grants are prefixed:—

	£	s.	d.
Mathematics and Physics.			
*Cayley, Prof.—Printing Mathematical Table ...	159	4	9
*Brooke, Mr.—British Rainfall	100	0	0
*Glaisher, Mr. J.—Luminous Meteors (25*l.* renewed)	30	0	0
*Maxwell, Prof. C.—Testing the exactness of Ohm's Law (renewed)	50	0	0
*Stokes, Prof.—Reflective Power of Silver and other Substances (renewed)...	20	0	0
*Tait, Prof.—Thermo-Electricity (renewed)	50	0	0
Thomson, Sir W.—Tide Calculating Machine ...	200	0	0
Chemistry.			
*Roscoe, Prof.—Specific Volume of Liquids... ...	25	0	0
*Armstrong, Dr.—Isomeric Cresols and the Law of Substitution in the Phenol Series	10	0	0
Clowes, Mr. F.—Action of Ethylbromobutyrate on Ethyl Sod-aceto-acetate	10	0	0
*Allen, Mr.—Estimation of Potash and Phosphoric Acid	20	0	0
Geology.			
*Lubbock, Sir J., Bart.—Exploration of Victoria Cave, Settle...	100	0	0
*Evans, Mr. J.—Record of the Progress of Geology	100	0	0
*Evans, Mr. J.—Kent's Cavern Exploration... ...	100	0	0
*Herschel, Prof.—Thermal Conductivities of Rocks	10	0	0
*Hull, Prof.—Underground Waters in the New Red Sandstone and Permian	10	0	0
*Bryce, Dr.—Earthquakes in Scotland	20	0	0
Biology.			
*Sclater, Mr.—Record of the Progress of Zoology..	100	0	0
*Dresser, Mr.—Close Time for the Protection of Indigenous Animals	5	0	0
Balfour, Prof.—Physiological Action of Sound ...	25	0	0
Huxley, Prof.—Zoological Station at Naples ...	75	0	0
*Brunton, Dr. L.—Nature of Intestinal Secretion...	20	0	0
Fox, Col. Lane—Instructions for Use of Travellers	25	0	0
Fox, Col. Lane—Prehistoric Explorations	25	0	0
Statistics and Economic Science.			
Beddoe, Dr.—Examination of Physical Characters of the Inhabitants of the British Isles	100	0	0
Mechanics.			
*Froude, Mr. W.—Instruments for Measuring the Speed of Ships (renewed)...	50	0	0
Napier, Mr. J.—Effect of the Propeller on the Turning of Steam Vessels	50	0	0
	£1489	4	9

* Re-appointed.

I was fortunate enough to get a ticket for the Salisbury and Stonehenge excursion, for which the applications were very numerous. Mr. Blackmore's magnificent museum illustrating the Stone Age was a delight to all scientific minds; and the presence of the founder, his brother, and his brother-in-law, Mr. E. T. Stevens, enhanced the pleasure of the visit. The Cathedral and Stonehenge, in addition, made up a very full day's round. The Mayor of Bristol took a party to Bowood and Avebury. How the Rev. Bryan King obtained his data for estimating that Avebury was about seven centuries older than Stonehenge I cannot conceive. The Silbury tumulus afforded a splendid view to the visitors, if very little science could be got out of it. A third party, that drove through the Cheddar valley, saw at Stanton Drew yet a third of the famous stone erections so conveniently placed around Bristol. The Tortworth excursion was a really hard day's work among many varieties of rock, especially palæozoic, but it was as profitable as it was hard, for the geologist. The Bristol waterworks were of high interest for engineers; and the attractions of Bath, Wells, and Tintern were displayed to every advantage by reason of beautiful weather and hearty welcomes.

REPORTS.

Report of the Committee on Mathematical Tables.—The portion of the report that had been prepared by Prof. Cayley during the year contained a *résumé* of works and memoirs on the theory of numbers. The publication of the elliptic function tables had, under the direction of Mr. J. W. L. Glaisher, proceeded during the year, and the first sixty-four pages of the table, printed from the stereotype plates, were exhibited to the Section. It was expected that the whole table would be printed by the next meeting. Mr. Glaisher stated that considerable additions had been received from mathematicians relating to the report on general tables, and that it was probable a supplementary report on this subject might be presented at the next meeting of the Association.

Hyperelliptic Functions.—Mr. W. H. L. Russell stated the contents of the portion of his report that he had written in the year, and which related chiefly to memoirs of Weierstrass. His report would be completed in two more parts.

Report of the Committee on Mathematical Printing, by Mr. W. Spottiswoode.—At the Belfast meeting the committee, consisting of Mr. Spottiswoode, Professors Stokes, Cayley, Clifford, and Mr. J. W. L. Glaisher, was appointed to report on mathematical notation and printing, with the view of leading mathematicians to prefer in optional cases such forms as are more easily put into type, and of promoting uniformity of notation. The report related wholly to printing, and contained a list of forms having the same signification, the one requiring "justification," and the other not (such as *ex. gr.* $\sqrt{a+x}$, and $\sqrt{(a+x)}$.) There were also attached diagrams showing the mechanical operation of setting up mathematical expressions in type, so that when there were two forms equally satisfactory from the mathematical point of view, writers might choose the one that would give the printer less trouble; as everything that tended to cheapen mathematical printing tended to the spread of the science. With regard to notation, the committee had thought it better not to report, feeling that in presence of the differences of opinion that must exist, it would be desirable that the matter should be discussed by a larger committee. The committee was reappointed to report on mathematical notation, with the addition of Sir Wm. Thomson, Professors H. J. S. Smith and Henrici, and Lord Rayleigh.

Report of the Committee on Tides, by Sir William Thomson.—He remarked that tides rise and fall in a series of harmonic vibrations, like the various tones in music, some tidal waves being due to the moon, others to the sun, others to meteorological causes. Even the overtones in music—so thoroughly studied by Helmholtz—were represented in the tidal waves. The committee had been engaged upon tides for a long time, and had shown the Government, harbour authorities, and others interested, the way to continue the work, but it could do so itself no longer, for he believed that day to be the last of the existence of the committee. The calculations connected with tidal observations were of a laborious nature. Col. Walker, of the Trigonometrical Survey of India, had helped the committee very much by printing the forms required for the calculations. Col. Walker had also had a series of tidal observations made in the Indian seas, and might possibly send the results home to have the calculations made from them. The Indian Government would probably have further observations made, especially in an important new harbour they were constructing at Madras. A great mass of other observations was accumulating. Mr. H. C. Russell, the Government astronomer at Sydney, had made several years' tidal observations, but had been obliged to stop them on account of the cessation of the grant for the work, but he hoped that the duty would be undertaken once more; as yet, the committee had no reductions whatever of tidal observations in the southern hemisphere, and knew nothing about the tides there. He had been promised a long series of observations, extending over eighteen years, from Brest, and he had applied for a series of eighteen years' observations from Toulon; so that he expected to obtain some information about tides on the French coast. The Tidal Committee had had some assistance from the Royal Society, which had given it a grant of 100*l.* to carry on tidal calculations. It had thus ascertained that the tides in Erebus Bay were connected with the Atlantic and not with the Pacific. Sir William Thomson then exhibited to the meeting and described his tide-gauge and tide-calculating machine, the latter being an improvement on that first described at Brighton and shown at Bradford two years ago. Although the old committee on tides ceased to exist at this meeting, a new one was appointed, consisting of Sir W. Thomson, Prof. J. C. Adams, Rear-Admiral Richards, General Strachey, Mr. W. Parkes, Col. Walker, Prof. Guthrie, Mr. J. W. L. Glaisher, Mr. John Exley, Mr. J. N. Shoolbred, and Mr. J. R. Napier, and the sum of 200*l.* was granted to them for completing and setting up in London, where it may be available for use, Sir William Thomson's tide-calculating machine. It was suggested that perhaps the machine might be placed at South Kensington.

Report of the Committee on Wave Numbers.—Portions of a letter were read from Mr. G. Johnstone Stoney relating to the work done in the year. At the Belfast meeting it was arranged that Mr. Stoney should interpolate Kirchhoff's lines into the table of wave numbers of the solar spectrum which Mr. Burton had prepared for the committee. When this was attempted, however, it was found that there were points requiring personal explanations from Mr. Burton, who was absent at Rodriguez on the Transit of Venus expedition, and the delay so occasioned had prevented any portion of the table being as yet printed. About thirty-four folios in manuscript, forming about two-thirds of the whole, were complete and were exhibited to the section.

An *interim Report of the Committee for testing experimentally Ohm's Law*, by Prof. Clerk-Maxwell, was read. It stated that he had had two compound resistance coils constructed by Warden and Co., one containing five equal, or nearly equal, coils of thirty ohms each, and the other two similar coils of thirty ohms, and by means of these he had devised a satisfactory test of Ohm's Law which could be worked to about $\frac{1}{10000}$. Nothing had, however, been done as yet. It was mentioned that Mr. Chrystal had compared the resistances of the standard coils belonging to the Association, and now in the Cavendish Laboratory at Cambridge.

Prof. Thorpe presented a preliminary *Report of the Committee appointed for the purpose of determining the specific volumes of liquids.* It gave a *résumé* of experiments upon certain liquids and gases, experiments made with a view of following up the work of Hermann Kopp, to whom almost all our knowledge of the subject is due, and further to arrive at definite conclusions with reference to the laws laid down by Kopp.

Prof. Corfield, on reading the *Report of the Sewage Committee*, observed that want of funds during the past year had prevented them from employing a sufficient amount of labour to obtain many useful results, but he was happy to state that the prospect for the ensuing year was brighter, as they had had a very liberal offer of pecuniary assistance. The observations which have been made on the Sewage Farm (situated near Romford) go to show that the weight of the crops removed from the land has increased each year. The great thing required is to make a comparison between the nitrogen taken up by the crops and the effluent nitrogen, and in order to accomplish this with accuracy it was necessary that the experiments should be constantly repeated, and should extend over a considerable number of years.

Report of Committee for considering the desirability of establishing a close time for the Protection of Indigenous Animals.—This report expressed regret that it had been found impossible to introduce the desired measure into Parliament this year in time to allow of its being carried; but Mr. Henry Chaplin, M.P. for that part of the Atlantic Doldrums which lies in the track of Mid-Lincolnshire, holds out the hope that he will bring forward such a measure early next session. The committee continue to receive assurances of the efficient working of the Sea Birds' Perservation Act of 1869.

The report (unfortunately the last) of the Sub-Wealden Exploration states that the new bore-hole has failed to penetrate to the Palæozoic rocks. The small diameter prevents tubing, and the sides now appear to be too friable to preserve verticality. Cessation of the work is hourly expected. The most noteworthy result of this heroic but unsuccessful investigation is the great thickness of the Kimmeridge clay, which, as was predicted by Mr. Searles Wood, considerably exceeds the estimate of the Sub-Wealden Boring Committee.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS AND PHYSICS

Dr. J. Janssen made four communications to the Section, the first of which related to the eclipse of April 1875, as observed at Bangchallô (Siam). He used a special telescope for the study of the corona. The results were—1. The establishing that the line 1474 is infinitely more pronounced in the corona than in the protuberances. This line seems even to stop abruptly at the edge of the protuberances without penetrating them. The light, then, which gives the line 1474 belongs entirely to the corona. This observation is one of the strongest proofs which can be adduced to prove that the corona is a real object, a matter radiating by itself. The existence of a solar atmosphere situated beyond the chromosphere—an atmosphere which M. Janssen had recognised in 1871, and proposed to call the coronal atmosphere—thus receives confirmation. 2. *Height of the coronal atmosphere.* In 1871 Dr. Janssen announced that the coronal atmosphere extended from half the sun's radius to a whole radius at certain points. This assertion has been confirmed not only by the direct views of the phenomenon, but also by photography. At Dr. Janssen's request Dr. Schuster took photographs of the corona with exposures of one, two, four, and eight seconds. In this series of photographs the height of the corona increases with the time of exposure. The height of the corona in the eight-seconds' photograph exceeds at some points a solar radius. (It is true that we ought to take account of the influence of the terrestrial atmosphere.) 3. As the sky was not of perfect clearness at Bangchallô, Dr. Janssen observed phenomena that explain previous observations of eclipses which seemed to invalidate the existence of the corona as a gaseous incandescent medium. On the whole, the observations of the 5th of April, 1875, have advanced us a fresh step in the knowledge of the corona by bringing forward new proofs of the existence of an atmosphere round the sun, principally gaseous, incandescent, and very extended.

In his second paper Dr. Janssen stated the results obtained by the expedition to Japan to observe the Transit of Venus. The expedition, which was under Dr. Janssen's direction, divided into two parts, the one taking up its station at Nagasaki and the other at Kobí. At Nagasaki Dr. Janssen observed the transit with an equatoreal of 8 inches aperture. (1) He obtained the two interior contacts. (2) He saw none of the phenomena of the drop or of the ligament; all the appearances were geometrical. (3) He observed facts which establish the existence of an atmosphere to Venus. (4) He saw the planet Venus before her entry on the sun, with suitable coloured glasses. This important observation proves the existence of the coronal atmosphere. (5) There was taken at Nagasaki a plate of the revolver for the first interior contact. (6) M. Tisserand observed the two interior contacts with a 6-inch equatorial; the contacts were sensibly geometrical. (7) Sixty photographs of the transit on silvered plates were obtained; and (8) also some other photographs (wet collodion and albumenised glass). At Kobí (weather magnificent) fifteen good photographs of the transit (wet collodion and albumenised glass) were obtained of about 4 inches in size; they will admit of being combined with the English photographs at the southern stations. The astronomical observation of the transit was successfully made by M. De la Croix, who was provided with a 6-inch telescope. His observations attest the existence of an atmosphere round Venus.

Dr. Janssen's third communication related to his magnetic observations in the Gulf of Siam and the Gulf of Bengal. He made observations at Bangkok, Bangchallô, Ligor, Singora, and Singapore, and concluded that the magnetic equator passes actually between Ligor and Singora, about 7° 43′ N. latitude. The *line without declination* passes very near to Singapore. In the Gulf of Bengal the equator passes through the north of Ceylon (the precise position will be given). The position of Ligor has been rectified. It is erroneously placed on the maps lat. 8° 24′ 30″.

Dr. Janssen had also made some observations which relate to mirage at sea. He had paid great attention to the phenomena in all his journeys since 1868, and had observed some very curious facts relating to mirage chiefly at sunrise and sunset. He found that (1) the mirage was almost constant at the surface of the sea; (2) that the appearances were explained by admitting the existence of a plane of total reflection at a certain height above the sea; (3) that the phenomena are due to a thermic and hygrometric action of the sea on the neighbouring atmospheric strata; (4) that there exist at sea direct, inverse, lateral, and other mirages; (5) that the phenomena have a very general influence on the apparent height of the sea horizon, which is sometimes diminished, sometimes increased. This variation of the apparent horizon it is very important to take into account, if we remember the use made of the horizon in nautical astronomy.

Prof. Hennessy, of Dublin, read two papers, one *On the influence of the physical properties of water on climate*, and the other *On the possible influence on climate of the substitution of water for land in Central and Northern Africa.* In the former the author referred to his earlier writings, in which he had taken an opposite view to Sir John Herschel, who stated that the effect of land under sunshine was to throw heat into the general atmosphere, and to distribute it by the carrying power of the air over the whole earth, and that water was much less effective in this respect, the heat penetrating its depths and being there absorbed, so that the surface never acquires a very elevated temperature even under the equator. Prof. Hennessy had arrived at the conclusion that of all substances largely existing in nature, water was that which was the most favourable to the absorption and distribution of solar heat throughout the external coating of the earth.

In his second paper, the author referred to the fact that more than six years since he had put forward proofs of the connection between some of the hot winds that blow from the south-west in Central and Southern Europe with the currents of the Atlantic, and not with the Desert of Sahara, as has been usually supposed. Similar views had been enunciated by Prof. Wild, director of the Physical Observatory of Russia, and others. The attention excited by the great midday heat of Central Africa caused many to overlook the remarkably low nocturnal temperature, and thus to ascribe to the desert a thermal influence that it does not possess. The author's views with regard to the physical properties of water in connection with climate, indicate that the substitution of an area of water over the Sahara for the existing dry land would be followed by the storing up of the heat received so largely in that region from the sun's rays which is now partly dissipated by nocturnal radiation. A great mediterranean sea in Africa would become a source of positive thermal influence on distant places. In the Red Sea the temperature is high by night as well as by day, and this would also occur in the hypothetical mediterranean of the Sahara. The climatal effect of this sea would upon the whole result in a higher mean temperature for these parts of the globe, and it would undoubtedly not operate in producing a lower temperature in Europe so as to cause a descent of the snow line. Its operation would probably be the reverse.

Prof. Osborne Reynolds read a paper *On the Force caused by the communication of Heat between a Surface and a Gas.*—This paper dealt chiefly with the remarkable discovery recently made by Mr. Crookes, that, under certain conditions, discs of pith suspended in a very perfect vacuum, and at the end of arms free to rotate, are made to spin round when light or radiant heat falls upon them. Prof. Reynolds said that he believed that Mr. Crookes asserted that radiant heat was attended by a force which produced this effect, but no such assumption would, he thought, explain the results. When a candle was presented the disc would tend to run away, and when a piece of ice was presented it would tend to follow; this showed that the force was not a radiative one, and he thought that, except as regarded the raising of the temperature of the body, radiant heat had nothing to do with the motions. The suspended body might give up its heat to the ether or to the surrounding gas, and thus propel itself, for the communication of this heat to the surrounding medium must be accompanied by a reaction. It had been said that Mr. Crookes used a perfect vacuum, so that there could be no gaseous reaction; but it remained to be proved that he used a vacuum so absolutely perfect. The greater the perfection of the vacuum the less was the resistance, and that was why the body appeared under such circumstances to be driven by a greater force. He had not witnessed the experiments with light, made by Mr. Crookes, but he thought that the results were probably due to the conversion of light into heat.—The discussion on this paper was adjourned, as it was hoped that Mr. Crookes would be able to be present; unfortunately, however, he was not able to arrive in time, and Prof. Balfour Stewart, the president, remarked that, as had been said by Prof. Stokes, it was doubtful whether Prof. Reynolds's explanation covered the whole ground. There was something else besides residual gas in the bulbs, viz., ether, and the particles of the radiometer might communicate more force to the ether when moving in one direction than when falling back again; consequently, motion might be given to the whole body to restore the balance. At all events Mr. Crookes's experiments were among the most interesting in the range of physical science.

Capt. H. Toynbee read a paper *On the physical geography of that part of the Atlantic Doldrums which lies in the track of ships crossing the Equator.* The paper was accompanied by diagrams, which showed the isobaric lines of mean pressure for each ·05 of an inch, together with arrows showing the prevailing winds and their force, also the isothermal lines for every second degree of air temperature, and further the isothermal lines for every second degree of sea temperature, together with arrows showing the prevailing currents and their speed in twenty-four hours. The paper called attention to important facts relating to atmospheric pressure, temperature, wind, currents, weather, sea-charts, natural history, earthquakes, &c. The diagrams gave monthly pictures of the Doldrums, showing how in some months they are wedge-shaped, as the late Commodore Maury remarked. The whole paper was a *résumé* of a work about to be published by the Meteorological Office.

Sir W. Thomson gave an account of the graphical process employed by him and Mr. J. Perry (now professor in Japan) for determining the form of a hanging drop, and other cases of the capillary surface of revolution.

On account of the interest attaching to the address of the President of the Mechanical Section *On Stream Lines*, and to the fact that as it was being delivered simultaneously with Prof. Balfour Stewart's address only a few members of this Section were able to hear it, Mr. Froude repeated it and the experiments with which it was accompanied again in Section A on the Tuesday morning. One experiment in particular was very interesting. A wooden wheel was fixed at a height of about 14 feet, and an endless chain hanging loosely over the wheel in a loop drooped to within 4 feet of the ground. When the wheel with its suspended chain was made to rotate rapidly by means of multiplying gear, the links of the chain symbolised the particles of a running stream of water. When the chain was struck, while it was rotating, with a wooden mallet, the curved forms into which it was thus beaten were to some extent persistent, as if it were a stiff, fixed wire rope, instead of being a loose chain in motion. Mr. Froude said that this experiment illustrated how water in flowing through pipes did not tend to push them straight, but rather adapted its motions to their curvatures.

In a letter from Mr. Meldrum, of Mauritius Observatory, written to accompany forty-nine tables (which, however, had not arrived), he expressed an opinion that the evidence adduced in favour of a rainfall periodicity was so strong that he believed we should by and by be able to predict the general character of the seasons.

Communications were made to the Section by Mr. H. A. Rowland, of John Hopkins University, Baltimore, *On the Magnetising Function of Iron, Nickel, and Cobalt*, and *On Magnetic Distribution*; and Mr. A. Malloch explained a method he had found accurate and convenient for producing a sharp meridian shadow.

On the whole, the physical papers read before the Section were not equal to the average of recent years, either in number or importance; but, as a compensation, the number of mathematical papers was unprecedented, and the Bristol meeting will be remembered both on this account and for the numerous attendance of mathematicians. On the Saturday, which has by custom long been set apart for mathematics, no less than twenty-four papers (including the three reports noticed in another column) on pure mathematics were read. Prof. Cayley explained the theory of the analytical functions which he had termed factions. Sir W. Thomson had three papers all relating to the mathematical treatment of the differential equations that occur in Laplace's theory of the tides. Prof. H. J. S. Smith explained the effect of the quadric transformation on the singular points of a curve, showing how singularities lying upon one side of the triangle of reference became transformed into singularities of a higher order at the opposite angle; and in another paper of great interest he pointed out the connection between continued fractions and points in a line (for example, between $\frac{24}{7}$ expressed as a continued fraction, and the order in which the points of section occur if a given line be divided into twenty-four and also into seven parts). Prof. Smith also spoke on the subject of singular solutions. Prof. Clifford's communications related to the theory of linear transformations, and one contained a graphical representation of invariants. Mr. J. W. L. Glaisher gave some theorems on the nth roots of unity, and explained a formula of verification in partitions, which was founded on and is complementary to one communicated by Sylvester to the Edinburgh meeting in 1871, viz., that

$$\Sigma(1 - x + xy - xyz + \ldots) = 0,$$

while the theorem in the paper was that

$$\Sigma(1 + x + xy + xyz + \ldots) = \Sigma 2^r,$$

r being the number of different elements employed in any partition. Mr. H. M. Jeffery's papers related to cubic spherical curves with triple cyclic arcs and triple foci, and to the shadows of plane curves on spheres. Mr. H. M. Taylor's paper contained a contribution to the mathematics of the chess-board, and his process enabled him to determine by a mathematical procedure the relative values of the pieces at chess probably as accurately as they admit of being found. Prof. R. S. Ball's communication related to a screw-complex of the second order, and Prof. Everett spoke on motors. Prof. Paul Mansion, of Ghent, had sent two papers, one containing an elementary solution of Huyghens's problem on the impact of elastic balls, and the other relating to singular solutions. Mr. W. Hayden contributed some geometrical theorems.

SECTION C—GEOLOGY

After the President's address, a lengthy and elaborate paper on the Northern End of the Bristol Coalfield was read by Messrs. Handel Cossham, E. Wethered, and Walter Saise. The paper was illustrated by many maps and sections. This was followed by a paper by Mr. J. M'Murtrie on mountain limestone lying in isolated patches at Luckington and Vobster. The singularity of this case will be realised when it is mentioned that the mountain limestone lies above the coal-measures, which, when originally deposited, overlaid the limestone. The Geological Survey examined the ground many years ago, and came, not unnaturally, to the conclusion that the limestone areas were bounded on all sides by faults. Mr. M'Murtrie has been able to show that the coal-measures are continued without disturbance beneath the limestone. The whole thing is inverted, and much interesting talk arose as to the possible movements which could have produced so great a displacement. Mr. Moore, of Bath, followed with an account of the deposits of Durdham Down yielding *Thecodontosaurus*. The age of the deposit in which this most remarkable Dinosaurian occurs was discussed at some length, but no definite result was arrived at, and the discussion was deferred till Monday.

Mr. Stoddart described an auriferous limestone found at Walton. The metal was distributed through the mass in extremely minute quantity, and the difficulty of obtaining recognisable samples was very great.

Prof. Hughes's paper, *On the Classification of the Sedimentary Rocks*, began by pointing out that the great divisions are not now drawn where the greatest breaks, all evidence considered, occur in nature. The sequence may be shortly given in these terms. Laurentian—Gap—Labrador Series—Gap [? Huronian—Gap] — Cambrian (from red conglomerates of St. David's up to base of May Hill Sandstone)—Gap—Silurian (from May Hill Sandstone = Upper and Lower Llandovery, to top of Red Marls of Sawdde and Horeb Chapel)—Gap—Carboniferous (from bottom of Devonian and Upper Old Red to top of Upper Coal Measures)—Gap—Jurassic (from bottom of breccia and conglomerates of so-called Permian and New Red to top of fluviatile and estuarine deposits of Weald.) The author deferred the full consideration of the rocks above this horizon to a future time, merely commenting on some of the points which seemed to him more especially to call for change.

In supporting this classification he criticised the division of the May Hill Sandstone into Upper and Lower Llandovery, and commented severely upon the re-naming of these beds, which had been previously correctly described by Prof. Sedgwick under the title May Hill Sandstone. He went into the Cambrian and Silurian controversy at some length, and pointed out that not only was Sedgwick's classification found to be the best in the present state of our knowledge, but that Murchison's had not correctly placed any one of the beds about which he came in collision with Sedgwick. What Murchison then called Caradoc overlapping Llandeilo at Llandeilo, has turned out to be May Hill Sandstone; what Murchison then called Cambrian underlying Llandeilo Flags, has turned out to be Caradoc resting on them, and part of the Llandeilo has had to be turned the other way up. The Survey corrected this, and it has appeared corrected in Murchison's later works, but he has never allowed that Sedgwick was right and he was wrong in 1839. Prof. Hughes thought it was too bad that some should still claim for Murchison the credit of having correctly placed the Ludlow and Wenlock, Caradoc and Llandeilo, but say nothing of the names having at that time been applied to totally different rocks.

He considered the Devonian and Upper Old Red to have been deposited over a continental area which sunk first on the south: hence the earlier character of the Devonian fauna in the south, and the greater denudation of the pre-Devonian land of the north. The Permian he wished to abolish as a separate formation, as it was a group made up of some stained carboniferous rocks and some of Sedgwick's previously described Magnesian Limestone and New Red. He thought that the continental area on whose submerged surface the New Red was deposited sunk unequally, and that conglomerates, where there was material to furnish them, were formed along the receding shore line, but at different dates as different parts of the land got down below the waves. He challenged anyone to show a section in which a greater break could be seen between the Trias and so-called Permian than several which occur amongst various members of the Upper New Red itself—and commented upon the unsatisfactory character of the palæontological evidence and of the stratigraphical evidence derived from tracing lines through a district where the rock was seldom seen.

Prof. Hull commented upon the difficulty of introducing any material changes in a nomenclature now so widely accepted. Prof. Harkness stated that he was in favour of adopting the classification of Silurian rocks given in Lyell's "Student's Manual." In reply, Prof. Hughes maintained his original claims with much humour and energy.

Prof. Hébert's very interesting communication on Undulations in the chalk of the North of France had special reference to the strata likely to be encountered in the drift-way of the Channel Tunnel. The Professor considered that observations of dips established the existence of two series of folds, one transverse to the other, which by their intersection produce bosses, or geological hills. The lower rocks, and notably the Greensand, may thus come to the surface in the Channel, and admit the seawater through their porous substance. Sir John Hawkshaw was present, and combated the geological difficulties with great success. A course of no fewer than five hundred borings, made by a plunger from the side of a vessel, had satisfied him of the substantial accuracy of the geological map of the Straits constructed from shore observations, and the information yielded by these borings was in his opinion adequate to prove that the tunnel will run through Lower Chalk in its whole extent. A small irregularity, bringing in some less compact rock, may be successfully and easily encountered by the engineer. In answer to a suggestion that the shallow holes made by the plunger might be deceptive, owing to a superficial detritus along the floor of the Straits, Sir John Hawkshaw explained that the strong wash of the Channel produced a perfectly clean floor. All along the Straits the instrument had brought up chalk where chalk was expected, and gault where gault was expected, and these formations had a perfectly definite boundary upon the floor of the sea.

A paper by Mr. Sanders described some large bones from the Rhætic beds of Aust Cliff. The dimensions of these fragments are so great as to suggest a large Dinosaurian, but the absence of any medullary cavity seems to imply that the body was habitually submerged. The articular ends, which might be expected to yield useful characters, are not preserved. A communication from Mr. Brodie opened the question of the extent and classification of the Rhætic beds. The interesting discovery of these deposits at Leicester formed the chief and most novel feature of the discussion. Confident statement was on the whole more conspicuous than matured reasoning in this part of the proceedings of the Section, and much evidently remains to be done to elucidate the palæontological and physical relations of the deposits in question. For the moment the preponderance, at least of authority, rests with those who affirm the universal spread of a Rhætic age, and look in every quarter of the globe for a bone-bed with Ceratodus and an *Avicula-contorta* zone.

A large audience assembled to hear Dr. Carpenter's paper on the red clay found by the *Challenger*. The substance of his remarks has already appeared in the Proceedings of the Royal Society.

The greater part of Tuesday's sitting was occupied by papers and discussion upon the Glacial Period. By this time the easily observable glacial phenomena have been co-ordinated, and there is not quite so much room as formerly for supposition and unconnected facts. The discussion elicited a few curious points, and was interesting, if not particularly instructive. Most readers of such modern summaries as are given in Lyell's "Principles" or Geikie's "Ice Age" would demur to the too sweeping language in which the Chairman summed up the argument. Dr. Wright's opinion that no man living knows anything of the Glacial Period may possibly be just, but it is not sufficiently incontestable to be enunciated *ex cathedrâ*. The most novel points of Dr. Carpenter's communication upon the "Sea Bottom of the North Pacific" were the low temperature of the water at great depths, and the supposed existence of coral reefs, drowned by too rapid submergence, upon all the submarine summits. The species are believed to be recent, and the submergence comparatively modern. Some notice was taken of the results obtained by the *Valorous*, and of Mr. Gwyn Jeffreys' view that the Arctic shells of the Sicilian Tertiaries were derived from polar areas by migration through a marine gap not far distant from the present canal of Languedoc. Mr. Thomson's views as to some new genera of fossil corals, which met heavy criticism at the Geological Society, were brought up once more here, but gained no support of consequence. The method of investigation is curious, but it has hitherto proved somewhat barren of results.

Among other good papers may be cited Prof. A. H. Green's account of the Millstone Grit of North Derbyshire and South Yorkshire. This was a highly-condensed statement of the stratigraphical relations of an extensive group of very interesting rocks. The variations in thickness of the different grits were referred to inequalities of the old sea-floor upon which they were accumulated, hollows permitting a greater thickness to form. Had discussion been allowed, it would have been interesting to notice the remarks thrown out by those classifiers of strata who regard the formation of every rock as a definite and almost universal event in the earth's history. Rarely has a better example been given than this of the local conditions, often quite trivial in themselves, which regulate the extent, divisions, and thickness, as well as the mineral and fossil characters of a large formation.

SECTION D.

BIOLOGY.

OPENING ADDRESS BY DR. P. L. SCLATER, M.A., F.R.S., F.L.S., PRESIDENT.[*]

V.—NEOTROPICAL REGION.

The Neotropical Region is, I suppose, on the whole the richest in animal life of any of the principal divisions of the earth's surface. Much work has been done in it as regards every branch of zoology of late years, and I must confine myself to noticing the most recent and most important of the contributions to this branch of knowledge.

I believe the following[†] to be altogether the most natural sub-divisions of the Neotropical Region, which are nearly as they are set forth in Hr. v. Pelzeln's "Ornithology of Brazil."

1. *Central American Sub-region*, from Southern Mexico to Panama.

2. *Andean* or *Columbian Sub-region*, from Trinidad and Venezuela, along the chain of the Andes, through Columbia, Equador, and Peru, down to Bolivia.

3. *Amazonian Sub-region*, embracing the whole watershed of the Orinoco and Amazons up to the hills, and including also the highlands of Guiana.

4. *The South Brazilian Sub-region*, containing the wood-region of S.E. Brazil and Paraguay and adjoining districts.

5. *The Patagonian Sub-region*, containing Chili, La Plata, Patagonia, and the Falklands.

Besides these we have:—

6. *The Galapagos*, which, whether or not they can be assigned to any other sub-region, must be spoken of separately.

I. THE CENTRAL AMERICAN SUB-REGION

was, up to twenty years ago, very little known, but has recently been explored in nearly every part, and is perhaps now more *nearly* worked out than any other of the above-mentioned sub-regions. There is as yet no complete work on the zoology of any portion of it, and the discoveries of Sallé, Boucard, de Saussure, and Sumichrast in Mexico, of Salvin in Guatemala, of v. Frantzius and Hoffman in Costa Rica, of Bridges and Arcé and Veragua, and of McLeannan in Panama, together with those of numerous other collectors, are spread abroad among the scientific periodicals of Europe and America. Even of Mexican zoology, long as it has been worked, we have no general account. To mention all these memoirs in detail would be impossible within the limits of this address; but I will say a few words about the more important of them that have lately appeared.

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[*] Continued from p. 382.

[†] A general sketch of the Mammal-life of this region is given in my article on the Mammals of South America in the Quar. Journ. of Science for 1865, and a Summary of the Birds in Sclater and Salvin's "Nomenclator Avium Neotropicalium."

The French are now publishing a work on the results of their scientific expedition to Mexico during the short-lived Empire. Three parts on the Reptiles by Duméril and Bocourt were issued in 1870, and a part on the Fishes, by L. Vaillant, has recently appeared.

A paper on the Mammals of Costa Rica has lately been published by v. Frantzius in Wiegmann's Archiv. Unfortunately, it seems to have been drawn up mainly from notes without reference to the specimens in the Berlin Museum, but nevertheless contains much that is useful and of interest.

Dr. Günther's admirable memoir of the fishes of Central America, published in the Zoological Society's "Transactions" in 1869, is based upon the collections made by Capt. Dow in various parts of the coast, and by Messrs. Salvin and Godman in the freshwater lakes of the highlands of Guatemala and in other localities.

Its value in relation to our general knowledge of the fishes of this portion of America, heretofore so imperfectly known, can hardly be over-estimated. As regards the birds of Central America, it is much to be regretted that we have at present no one authority to refer to. The collection of Messrs. Salvin and Godman embraces very large series from different parts of this region, and together with those of my own collection, wherein are the types of the species described in my own papers, would afford abundant materials for such a task. Mr. Salvin and I have often formed plans for a joint work on this subject, and I trust we may before long see our way to its accomplishment. A similar memoir on the Mammals of Central America is likewise of pressing necessity for the better understanding of the Neotropical Mammal Fauna. There are considerable materials available for this purpose in the collections of Salvin and Arcé in the British Museum, and I trust that some naturalist may shortly be induced to take up this subject.

2. THE ANDEAN OR COLUMBIAN SUB-REGION.

Of this extensive sub-region, which traverses six or seven different States, there is likewise no one zoological account; but I may mention some of the principal works lately issued that bear upon the subject. Léotaud's "Birds of Trinidad" gives us an account of the ornithology of that island, which forms a kind of appendage to this sub-region, and Dr. Finsch has more recently published a supplementary notice of them. Of Venezuela, Columbia, and Ecuador there are only scattered memoirs in various periodicals on the numerous collections that have of late years been made in those countries to be referred to. Several excellent collectors are now, or lately have been, resident in these republics, Herr Georing and Mr. Spence in Venezuela, Mr. Salmon in Antioquia, Professor Jameson and Mr. Fraser in Ecuador, whose labours have vastly added to our knowledge of the zoology of these districts. When we come to Peru, we have Tschudi's "Fauna Péruana" to refer to, which, though unsatisfactory in execution, contains much of value. How far from being exhausted is the rich fauna of the Peruvian Andes, is sufficiently manifest from the wonderful discoveries lately made by Jelski in the district east of Lima, which was in fact that principally investigated by Tschudi. Of these, M. Taczanowski has lately given an account as regards the birds in the Zoological Society's "Proceedings"; and Dr. Peters has published several notices of the more remarkable Mammals and Reptiles.

Further south, in Bolivia, our leading authority is still the zoological portion of D'Orbigny's "Voyage dans l'Amérique Méridionale." This rich and most interesting district has, it is true, been visited by several collectors since D'Orbigny's time; but the results of their journeys have never been published in a connected form, though many of their novelties have been described. Bolivia, I do not doubt, still contains many new and extraordinary creatures hid in the recesses of its mountain valleys; and there is no part of South America which I should sooner suggest a promising locality for the zoological collector.

3. THE AMAZONIAN SUB-REGION.

On Guiana, where the Amazonian fauna seems to have had its origin, we have a standard work in Schomburgk's "Reise," the third volume of which, containing the Fauna, was drawn up by the Naturalist of the Berlin Museum. For the valley of the Amazons itself, the volumes of Spix and Martius, though not very accurate, and rather out of date, must still be referred to, as likewise the zoology of Castelnau's "Expédition dans l'Amérique du Sud," for the natural history of the Peruvian confluents. As regards the birds, however, we have several more recent authorities. In 1873 Mr. Salvin and I published in the Zoological Society's "Proceedings" a *résumé* of the papers treating of Mr. E. Bartlett's and Mr. John Hauxwell's rich ornithological collections on the Huallaga, Ucayali, and other localities in Eastern Peru. Subsequently we communicated to the same Society an account of Mr. E. L. Layard's collection of birds made near Para, and took occasion to deduce therefrom some general ideas as to the relations of the Avifauna of the Lower Amazons.

As regards the two lower great confluents of the Amazons, Rio Madeira on the right bank, and the Rio Negro on the left bank of the mighty river, our knowledge of their avifaunas is mainly due to the researches of Johann Natterer—one of the most successful and energetic zoological collectors that ever lived—of whose discoveries in ornithology a complete account has lately been first published by Mr. A. v. Pelzeln, of Vienna. It is much to be wished that a similar *résumé* of Natterer's discoveries and collections of Mammals, in which order his investigations were of hardly less importance, should be given to the world; and I trust Herr v. Pelzeln will forgive me if I press this subject on his attention.

The fishes of the Amazons and its confluents are many and various, and fully deserve a special monograph. The late Professor Agassiz made his well-known expedition up the Amazons in 1865 with the particular view of studying its fishes, and amassed enormous collections of specimens for the purpose.* Whether (as other naturalists have hinted) Professor Agassiz's estimate of the number of new and undescribed species contained in their collection was exaggerated or not is at present uncertain, as the specimens unfortunately lie unstudied in the Museum of Comparative Zoology at Cambridge, Mass. It is a thousand pities this state of things should continue; and I venture to suggest to the great Professor's numerous friends and admirers in the U. S. that no more appropriate tribute to his memory could be raised than the publication of a monograph of Amazonian fishes based on their collections.

4. THE SOUTH-BRAZILIAN SUB-REGION.

This sub-region, which embraces the wood region of S.E. Brazil and adjoining districts, and contains in nearly every branch of zoology a set of species and genera allied to but separable from those of the Amazonian Sub-region, has been much frequented by European naturalists. Its productions are consequently tolerably well known, though there is even here still very much to be done. Burmeister's "Systematische Ubersicht" and "Erläuterungen" may be referred to for information on its Mammals and Birds; likewise Prince Max. of New Wied, "Beiträge," which, although of old standing in point of date, is still of great value. The late Dr. Otto Wucherer, a German physician resident at Bahia, paid much attention to the Reptiles of that district, and has written an account of its Ophidians which will be found in the Zoological Society's "Proceedings."

Hr. Hensel has also recently published in Wiegman's "Archiv" a valuable memoir on Mammals collected in South Brazil, which should be referred to. Prof. Reinhardt has recently completed an excellent account of the avifauna of the Campos of Brazil, based on his own collections and those of Dr. D. W. Lund; and Hr. v. Berlepsch has treated of the birds of Santa Catharina. These are all three most useful contributions to our knowledge of this sub-region. But it is melancholy to think that although a (*soi-disant*) highly civilised European race has resided in the Brazilian Empire so long, and has introduced railways, steamboats, and many other of the appliances of modern Europe, there has never, so far as I know, been produced by them any one single memoir worthy of mention on the teeming variety of zoological life that everywhere surrounds them.

For information on the animals of Paraguay we must still refer to the writings of Don Felix d'Azara, and to Dr. Hartlaub's reduction of his Spanish terms to scientific nomenclature. But modern information about this part of the South-Brazilian Sub-region would be very desirable.

5. THE PATAGONIAN SUB-REGION.

For the zoology of the Argentine Republic, which forms the northern portion of this sub-region, the best work of reference is the second volume of Dr. Burmeister's "La-Plata Reise," which contains a synopsis of the Vertebrates of the Republic. Dr. Burmeister, who is now resident at Buenos Ayres as director of the public museum of that city, has lately devoted himself to the study of the extinct Mammal-fauna, and specially to that of the Glyptodont Armadillos, of which he has lately completed a splendidly illustrated monograph. He has likewise been the chief adviser of the Government in their plans for recognising the University of Cordova, which will ultimately no doubt do much for the cause of natural science in the Argentine Republic. Mr. W. H. Hudson, of Buenos Ayres, has long studied the birds and other animals of that country, and deserves honourable mention in a country where so few of the native-born citizens pursue science. His bird-collections have been worked out by Mr. Salvin and myself, and Mr. Hudson has likewise published a series of interesting notices on the habits of the species.

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* See "Travels in Brazil," by Prof. and Mrs. Louis Agassiz, Boston, 868.

The "Zoology of the Voyage of the *Beagle*" contains much information concerning the animals of La Plata, Patagonia, and Chili. The "Mammals" by Waterhouse, the "Birds" by Gould and G. R. Gray, the "Fishes" by Jenyns, and the "Reptiles" by Bell, illustrated with notes and observations of Mr. Darwin, will ever remain among the leading authorities on the animals of this part of America. On the Rio Negro of Patagonia, where Mr. Darwin made considerable collections, we have a more recent authority in Mr. W. H. Hudson, whose series of birds from this district was examined by myself in 1872.

Dr. R. O. Cunningham has recently followed on the footsteps of Mr. Darwin in Patagonia, and besides his journal of travels has published notes on the animals met with, in the Linnean Society's Transactions. Mr. Salvin and I have given an account of his ornithological collections in several papers in the "Ibis."

As regards the Falkland Islands, two excellent collectors and observers have of late years been stationed there, and have provided the means of our becoming well acquainted with the native birds. Capt. Packe's collections have been examined by Mr. Gould and myself, and Capt. Abbott's by myself in a paper to which he has added many valuable notes.

Lastly, as regards Chili, we have Gay's somewhat pretentious "Fauna Chileña," forming the zoological portion of his "Historia Fisica y Politica de Chile." The volume on the Mammals and Birds was compiled at Paris by Desmurs, and that on the Reptiles and Fishes by Guichenot, but they are not very reliable. The naturalists of the National Museum of Santiago, Philippi and Landbeck, have of late years published in Wiegman's "Archiv" many memoirs on the zoology of the Chilian Republic, of which I have given a list in a paper on the Birds of Chili in the Zoological Society's "Proceedings" for 1867. More recently Messrs. Philippi and Landbeck have published a catalogue of Chilian birds in the "Anales de la Universidad de Chile." But Mr. E. C. Reed, F.Z.S., who is likewise attached to the museum of Santiago, writes me word that he is now engaged in preparing for publication a complete revision of the Vertebrates of the Republic, which will no doubt give us still better information on this subject.

6. GALAPAGOS.

Until recently our knowledge of the very singular fauna of the Galapagos was mainy based upon Mr. Darwin's researches, as published in the "Zoology of the *Beagle*," above referred to. Recently, however, Mr. Salvin and I have described some new species of birds from these islands from Dr. Habel's collection, and Prof. Sundevall has published an account of the birds collected there during the voyage of the Swedish frigate *Eugénie* in 1852. Mr. Salvin has likewise prepared and read before the Zoological Society a complete memoir on the Ornithology of the Galapagoan Archipelago, which will shortly be printed in the Society's "Transactions." Much interest has likewise been recently manifested concerning the gigantic Tortoises of the Galapagos, which, Dr. Günther has reason to believe, belong to several species each restricted to a separate island.* Indeed, I am much pleased to hear that the Lords of the Admiralty, incited by Dr. Günther's requests, have despatched H.M.S. *Tenedos* for the Pacific squadron at Panama to the Galapagos, for the express purpose of capturing and bringing to England specimens of the tortoises of each of the islands. We may, therefore, hope to be shortly more accurately informed upon this most interesting subject.

V*a*. THE ANTILLEAN SUB-REGION.

The study of the fauna of the West India Islands presents problems to us of the greatest interest: first, on account of the relics of an ancient and primitive fauna which are found there, as indicated by the presence of such types as *Solenodon*, *Dulus*, and *Starnœnas*; and, secondly, from the many instances of representative species replacing each other in the different islands. Much, it is true, has been done towards the working out of Antillean Faunas of late years, but much more remains to be done; and it is indeed scandalous that there should be many islands under the British rule, of the zoology of which we are altogether unacquainted. The greater activity of our botanical fellow-labourers has supplied us with a handy volume of the Botany of these islands;* and it is by no means creditable to the zoologists to remain so far behind in this as in other cases already alluded to. Within the compass of the present address it would not be possible for me to enumerate all our authorities upon Antillean zoology, but I will mention some of the principal works of reference under the following heads:—

1. *The Bahamas.*
2. *Cuba.*
3. *Jamaica.*
4. *Haiti.*
5. *Porto Rico.*
6. *The Lesser Antilles.*

1. *The Bahamas.*

The late Dr. Bryant has published in the *Boston Journal of Natural History* several articles upon the birds of the Bahamas, where he passed more than one winter. These islands, however, merit much more minute investigation than has as yet been bestowed upon them.

2. *Cuba.*

Ramon de la Sagra's "Historia Fisica y Politica de Cuba" and Lenbeye's "Aves de la Isla de Cuba," were up to a recent period our chief authorities upon Cuban zoology. But Cuba has long had the advantage of the residence within it of an excellent naturalist—Don Juan Gundlach—who has laboured hard towards the more complete investigation of its remarkable zoology. We are indebted to him for collecting the specimens upon which Dr. Cabanis based his revision of Cuban ornithology, published in Wiegmann's "Archiv," as also for a tabular list of Cuban birds, published in the same journal for 1861, and for several supplements thereto, for the more recent reviews of the mammals and birds of the island, published in the first volume of Poey's "Repertorio," and for many other contributions to the natural history of Cuba. This last-named work, as also the previous "Memorias sobre la historia natural de la Isla de Cuba" of the same author, contains a number of valuable contributions to our knowledge of the rich fauna of this island, and should be carefully studied by those who are anxious to become acquainted with the peculiarities of the Cuban fauna.

3. *Jamaica.*

Mr. Gosse's meritorious work on the Birds of Jamaica, and his "Naturalists' Rambles," are still the main source of our information on the fine island of Jamaica, and very little has been done since his time. A young English naturalist, Mr. W. Osburn, made some good collections in Jamaica in 1860, of which the Mammals were worked out by Mr. Tomes and the Birds by myself. Mr. W. T. March has also more recently sent good series of the birds of the island to America, and Prof. Baird has edited his excellent notes on them. I must not lose the opportunity of calling special attention to the Seals of the Antilles (*Monachus tropicalis* and *Cystophora antillarum* of Gray), of which, so far as I know, the only specimens existing are the imperfect remains in the British Museum brought home by Mr. Gosse. More knowledge about these animals (if there be really two of them) would be very desirable.

4. *Haiti.*

Of this large island very little more is known as regards its zoology than was the case in the days of Buffon and Vieillot. Of its birds alone we have a recent account in a paper which I wrote upon M. Sallé's collection, and in a more recent memoir drawn up by the late Dr. Bryant, and published in the "Proceedings" of the Boston Society of Natural History for 1863.

5. *Porto Rico.*

Nearly the same story holds good of this Spanish island, of which our only recent news relates to the birds, and consists of two papers—one by Mr. E. C. Taylor in the "Ibis," and the other by the late Dr. Bryant, in the journal above mentioned.

6. *The Lesser Antilles.*

As I remarked above, every one of the numerous islands, from Porto Rico down to Trinidad, requires thorough examination.

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* See NATURE, vol. xii. p 238 (1875).

* Griesbach's "Flora of the West Indies."

It is remarkable that no one has yet been found to attack this interesting subject, which might easily be performed by excursions during the winter months of a few succeeding years.

As regards the ornithology of these islands, the subjoined summary of what we really know and do not know is mainly taken from a paper on the Birds of St. Lucia, which I read before the Zoological Society of London in 1871.

1. *The Virgin Islands.*—Of these islands we may, I think, assume that we have a fair acquaintance with the birds of St. Thomas, the most frequently visited of the group, and the halting place of the West Indian mail steamers. Mr. Riise, who was long resident here, collected and forwarded to Europe many specimens, some of which were described by myself,[*] and others are spoken of by Prof. Newton in a letter published in the "Ibis" for 1860, p. 307. Mr. Riise's series of skins is now, I believe, at Copenhagen. Frequent allusions to the birds of St. Thomas are also made by Messrs. Newton in their memoir of the birds of St. Croix, mentioned below. In the "Proceedings" of the Academy of Natural Sciences of Philadelphia for 1860, Mr. Cassin has given an account of a collection of birds made in St. Thomas by Mr. Robert Swift, and presented to the Academy; twenty-seven species are enumerated.

Quite at the extreme east of the Virgin Islands, and lying between them and the St. Bartholomew group, is the little islet of Sombrero, "a naked rock about seven-eighths of a mile long, twenty to forty feet above the level of the sea, and from a few rods to about one-third of a mile in width." Although "there is no vegetation whatever in the island over two feet high," and it would seem a most unlikely place for birds, Mr. A. A. Julien, a correspondent of Mr. Lawrence of New York, succeeded in collecting on it specimens of no less than thirty-five species, the names of which, together with Mr. Julien's notes thereupon, are recorded by Mr. Lawrence in the eighth volume of the "Annals of the Lyceum of Natural History of New York."

The remaining islands of the Virgin group are, I believe, most strictly entitled to their name so far as ornithology is concerned, for no collector on record has ever polluted their virgin soil. Prof. Newton ("Ibis," 1860, p. 307) just alludes to some birds from St. John in the possession of Mr. Riise.

2. *St. Croix.*—On the birds of this island we have an excellent article by Messrs. A. and E. Newton, published in the first volume of the "Ibis."[†] This memoir, being founded on the collections and personal observations of the distinguished authors themselves, and having been worked up after a careful examination of their specimens in England, and with minute attention to preceding authorities, forms by far the most complete account we possess of the ornithology of any one of the Lesser Antilles. It, however, of course requires to be supplemented by additional observations, many points having been necessarily left undetermined; and it is much to be regretted that no one seems to have since paid the slightest attention to the subject.

3. *Anguilla, St. Martin, and St. Bartholomew.*—Of this group of islands St. Bartholomew alone has, as far as I know, been explored ornithologically, and that within a very recent period. In the Royal Swedish Academy's "Proceedings" for 1869 will be found an excellent article by the veteran ornithologist Prof. Sundevall, on the birds of this island, founded on a collection made by Dr. A. Von Göes. The species enumerated are forty-seven in number.

4. *Barbuda.*—Of this British island I believe I am correct in saying that nothing whatever is known of its ornithology, or of any other branch of its natural history.

5. *St. Christopher and Nevis*, to which may be added the adjacent smaller islands *St. Eustathius and Saba.*—Of these islands also our ornithological knowledge is of the most fragmentary description. Mr. T. J. Cottle was, I believe, formerly resident in Nevis, and sent a few birds thence to the British Museum in 1839. Amongst these were the specimens of the Humming-birds of that island, which are mentioned by Mr. Gould in his well-known work. Of the remainder of this group of islands we know absolutely nothing.

6. *Antigua.*—Of this fine British island, I regret to say, nothing whatever is known as regards its ornithology. Amongst the many thousands of American birds that have come under my notice during the past twenty years, I have never seen a single skin from Antigua.

7. *Montserrat.*—Exactly the same as the foregoing is the case with the British island of Montserrat.

8. *Guadeloupe, Deseadea, and Marie-galante.*—An excellent French naturalist, Dr. l'Herminier, was for many years resident as physician in the island of Guadeloupe. Unfortunately, Dr. l'Herminier never carried into execution the plan which I believe he contemplated, of publishing an account of the birds of that island. He sent, however, a certain number of specimens to Paris and to the late Baron de la Fresnave, to whom we are indebted for the only article ever published on the birds of Guadeloupe or of the adjacent islands.

9. *Dominica.*—Dominica is one of the few of the Caribbean islands that has had the advantage of a visit from an active English ornithologist. Although Mr. C. E. Taylor only passed a fortnight in this island in 1863, and had many other matters to attend to, he nevertheless contrived to preserve specimens of many birds of very great interest, of which he has given us an account in one of his articles on the birds of the West Indies, published in the "Ibis" for 1864. It cannot be supposed, however, that the birds of this wild and beautiful island can have been exhausted in so short a space of time, even by the energetic efforts of our well-known fellow-labourer.

10. *Martinique.*—This island is one of the few belonging to the Lesser Antilles in which birdskins are occasionally collected by the residents, and find their way into the hands of the Parisian dealers. There are also a certain number of specimens from Martinique in the Musée d'Histoire Naturelle in the Jardin des Plantes, which I have had an opportunity of examining; but, beyond the vague notices given by Vieillot in his "Oiseaux de l'Amérique du Nord," I am not aware of any publications relating specially to the ornithology of this island. Mr. E. C. Taylor passed a fortnight in Martinique in 1863, and has recorded his notes upon the species of birds which he met with in the excellent article which I have mentioned above; but these were only few in number. The International Exhibition in 1862 contained, in the department devoted to the products of the French colonies, a small series of the birds of Martinique, exhibited by M. Bélanger, director of the Botanical Garden of St. Pierre in that island.[*] This is all the published information I have been able to find concerning the birds of Martinique.[†]

11. *St. Lucia.*—Of this island I gave an account of what is known of the birds in a paper published in the Zoological Society's "Proceedings" for 1871, based upon a collection kindly forwarded to me by the Rev. J. E. Semper. Mr. Semper subsequently communicated some interesting notes on the habits of the species.

12. *St. Vincent.*—St. Vincent was formerly the residence of an energetic and most observant naturalist, the Rev. Lansdowne Guilding, F.L.S., well known to the first founders of the Zoological Society of London, who, however, unfortunately died at an early age in this island without having carried out his plans for a fauna of the West Indies.

Mr. Guilding paid most attention to the invertebrate animals; but his collections contained a certain number of birds, amongst which was a new Parrot, described after his decease by Mr. Vigors as *Psittacus Guildingii*, and probably a native of St. Vincent.

13. *Grenada and the Grenadines.*—Of the special ornithology of this group nothing is known.

14. *Barbados.*—The sole authority upon the birds of Barbados is Sir R. Schomburgk's well-known work on that island. This contains (p. 681) a list of the birds met with, accompanied by some few remarks. It does not, however, appear that birds attracted much of the author's attention; and more copious notes would be highly desirable.

15. *Tobago*, I believe, belongs zoologically to Trinidad. Sir W. Jardine has given us an account of its ornithology from Mr. Kirk's collections.

VI.—THE AUSTRALIAN REGION.

Of the Australian Region I will speak in the following subdivisions:—

1. *Australia and Tasmania.*
2. *Papua and the Papuan Islands.*
3. *The Solomon Islands.*

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[*] Ann. N.H. ser. 3, vol. iv. p. 225; and P.Z.S. 1860, p. 314.

[†] "Ibis," 1859, pp. 59, 138, 252, and 365.

[*] See an article on Ornithology in the International Exhibition, "Ibis," 1862, p. 288.

[†] On animals formerly living in Martinique but now extinct, see Guyon, "Comp. Rend." lxiii. p. 589 (1866).

That we know more of the fauna of Australia than of other English colonies in different parts of the world is certain, but no thanks are due from us for this knowledge either to the Imperial or to any of the Colonial Governments. The unassisted enterprise of a private individual has produced the two splendid works upon the Mammals and Birds of Australia, which we all turn to with pleasure whenever reference is required to a member of these two classes of Australian animals. Mr. Gould's "Mammals of Australia" was completed in 1863. Since that period the little additional information received respecting the terrestrial Mammals of Australia has been chiefly furnished by Mr. Krefft, of the Australian Museum, Sydney, in various papers and memoirs. Mr. Krefft has also written the letterpress to some large illustrations of the "Mammals of Australia," by Miss H. Scott and Mrs. H. Forde, in which a short account of all the described species is given. On the Marine Mammals, however, which were scarcely touched upon by Mr. Gould, we have a treatise by Mr. A. W. Scott published at Sydney in 1873, which contains a good deal of useful information concerning the seals and whales of the Southern Hemisphere.

The magnificent series of seven volumes of Mr. Gould's "Birds of Australia" was finished in 1848. In 1869 a supplementary volume was issued, containing similar full-sized illustrations of about 80 species. In 1863 Mr. Gould reprinted in a quarto form, with additions and corrections, the letterpress of his great work, and published it under the title of a "Handbook to the Birds of Australia." This makes a convenient work for general reference. Of two colonial attempts to rival Mr. Gould's series I cannot speak with much praise. Neither Mr. Diggle's "Ornithology of Australia" nor Mr. Halley's proposed "Monograph of the Australian Parrots" are far advanced towards conclusion—indeed, of the last-mentioned work I have seen but one number.

Several large collections of birds have been made in the peninsula of Cape York and adjoining districts of Northern Queensland of late years, and it is a misfortune for science that we have had no complete account of them. One of the largest of these, however, made by Mr. J. T. Cockerell, has luckily fallen into the hands of Messrs. Salvin and Godman, and will, I trust, be turned to better uses than the filling of glass cases and the ornamentation of ladies' hats.

It seems to me that there is still much to be done even in birds in Northern Australia, and I cannot help thinking that Port Darwin, the northern extremity of the trans-continental telegraph, would be an excellent station for a collecting naturalist, and one where many novelties, both zoological and botanical, would certainly be met with.

On the Snakes of Australia we have an excellent work published in 1869 by Mr. Gerard Krefft—one of the few really working Australian naturalists, who, it appears, is not appreciated in Sydney as he fully deserves to be. Mr. Krefft, during his long residence in Sydney, has become well acquainted with the Ophidians of the colony and has devoted special attention to them, so that he has the advantage of practical as well as scientific acquaintance with his subject. The late Dr. Gray has written many papers on the Tortoises and Lizards of Australia. Of the latter we have to thank Dr. Günther for a complete monographic list just published in one of the newly issued numbers of the "Voyage of the *Erebus* and *Terror*." Most of the plates of this work were also issued in 1867 by Dr. Gray in his "Fasciculus of the Lizards of Australia and New Zealand."

For information on the fishes of Australia reference must be made to the ichthyological portion of the "Zoology of the *Erebus* and *Terror*," by Sir John Richardson, and to the same author's numerous papers on Australian fishes in the "Annals of Nat. Hist." and "Transanctions" and "Proceedings" of the Zoological Society of London. The Count F. de Castelnau, who seems to be almost the only working ichthyologist in Australia, has recently published in the "Proceedings of the Zoological and Acclimatisation Society of Victoria," several papers on the fishes of the Melbourne fish-market and of other parts of Australia, which include a complete synopsis of the known Australian species.

2. PAPUA AND ITS ISLANDS.

I believe that my paper upon the Mammals and Birds of New Guinea, published by the Linnean Society in 1858, was the first attempt to put together the scattered fragments of our knowledge of this subject. In 1859 a British Museum Catalogue by Dr. J. E. and Mr. G. R. Gray, gave a *résumé* of the then known members of the same two classes belonging to New Guinea and the Aru Islands, and included notices of all Mr. Wallace's discoveries. In 1862 Mr. Wallace gave descriptions of the new species discovered subsequently to his return by his assistant, Mr. Allen. In 1863 Dr. Finsch published at Bremen an excellent little essay called "Neu-Guinea und seine Bewohner," in which is given a complete account of our then state of knowledge of the subject. But within these last ten years still more serious efforts have been made by naturalists of several nations to penetrate this *terra incognita*. Two emissaries of the Leyden Museum—Bernstein and V. Rosenberg—have sent home full series of zoological spoils to that establishment, and have discovered a host of novelties. Of these the birds have been described by Prof. Schlegel in his "Observations Zoologiques." An intrepid Italian traveller, Signor L. M. d'Albertis, made a still further advance, when in September 1872 he accomplished the first ascent of the Arfak Mountains,* and discovered the splendid Bird of Paradise and other new species which I described in 1873. Quickly following on his footsteps, Dr. A. B. Meyer penetrated still further into the unknown interior, and reaped the abundant harvest of which he has given us an account in six papers lately published at Vienna. Dr. Meyer has now become director of the Museum of Dresden, and is no doubt occupied in the further elaboration of his rich materials. In the meanwhile some accomplished Italian naturalists are engaged on the collections of D'Albertis and his quondam companion Beccari. Count Salvadori, who is at work on the birds, will take the opportunity of preparing a complete account of the ornithology of Papua and its islands, similar to that in Borneo, of which I have already spoken. The Marquis Giacomo Doria has already published one excellent paper on "The Reptiles of Amboina and the Ké Islands," collected by his compatriot Beccari, and is preparing other memoirs on the Mammals and Reptiles of New Guinea and the Aru Islands obtained by D'Albertis.

Dr. Meyer has lately given an account of his herpetological discoveries in New Guinea, which comprehend several new and most interesting forms, in a memoir read before the Academy of Berlin; and Dr. Bleeker some years ago gave a list of the reptiles obtained by V. Rosenberg in that island, and enumerated the Papuan reptiles then known to him.

All these expeditions, however, have been directed towards the western peninsula of New Guinea, which alone is yet in any way explored by naturalists. Of the greater south-eastern portion of the island (unless we are inclined to give credit to Capt. Lawson's wonderful exploits) we have as yet very little information. A cassowary † and a kangaroo, ‡ brought away by the *Basilisk* from the southern coast, both proved to be new to science, as did likewise a Paradise Bird obtained in the same district by Mr. D'Albertis. § This is sufficient to give us an idea of what we may expect to find when the interior of this part of New Guinea is explored. And I may take this opportunity of mentioning that a most active and energetic traveller is perhaps at this very moment at work there. M. L. M. d'Albertis, of whose previous labours I have just spoken, returned to the East last autumn. Letters received from him by his Italian friends in June last state that he had at the time of writing already succeeded in reaching Yule Island near Mously Bay, on the south-east coast of New Guinea, and proposes to establish his headquarters there for expeditions into the interior.

3. NEW IRELAND, NEW BRITAIN, AND THE SOLOMON ISLANDS.

I devote a few words specially to these islands because they are easy of access from Sydney, and because their productions are of particular interest, belonging, as they do, to the Papuan and not to the Polynesian fauna. I have put together what is known of the birds of the Solomon's group in a paper read before the Zoological Society in 1869. Seeing the interesting results obtained from the examination of one small jar of birds collected by an unscientific person, there can be little doubt of the value of what would be discovered on the more complete investigation of the group. As regards New Ireland and New Britain, we have but scattered notices to refer to. The last-named island is, we know, the home of a peculiar cassowary (*Casuarius bennetti*).

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* See NATURE, vol. viii. p. 501 (29).

† *Cazuarius picticollis*, Scl., P.Z.S. 1875, p. 85.

‡ *Dorcopsis luctuosa* (D'Albertis), *v.* Garrod, P.Z.S. 1875, p. 48.

§ *Paradisea raggiana*, Sclater, P.Z.S. 1873, p. 559.

A list of the fishes of the Solomon Islands is given by Dr. Günther in Mr. Brenchley's "Cruise of the *Curaçoa*," which I shall allude to presently.

VII.—PACIFIC REGION.

Of this region, where Mammals (except a few bats) are altogether absent, and birds are the predominant form of vertebrate life, I will say a few final words under three heads :—
1. *New Zealand.* 2. *Polynesia.* 3. *The Sandwich Islands.*

1. *New Zealand.*

In New Zealand, of all our Colonies, most attention has lately been devoted to natural history, and several excellent naturalists are labouring hard and well—I need only mention the names of Dr. Hector, Dr. Haast, Capt. F. W. Hutton, and Dr. Buller. The commendable plan of affiliating the various local societies together to one institute has resulted in the production of an excellent scientific journal, already in its sixth volume, which contains a mass of most interesting papers on the fauna and flora of the colony. To refer to these memoirs in detail is quite unnecessary; but it is obvious, on turning over the pages of the volumes of the Transactions of the New Zealand Institute, how great are the exertions now being made to perfect our knowledge of the natural products, both recent and extinct, of our antipodean colony.

Dr. W. L. Buller's beautiful volume on the ornithology of New Zealand, finished in 1873, is likewise a most creditable production both to the author and to those who have supported and promoted his undertaking. Few, indeed, are the colonies that can boast of a similar piece of work!

In 1843 the late Sir John Richardson presented to this association a special report on the Ichthyology of New Zealand; but much advance has, of course, been made since that period.

The lizards of New Zealand have been recently enumerated along with those of Australia in Dr. Günther's memoir above referred to.

2. POLYNESIA.

Great additions have recently been made to our knowledge of the natural productions of the Polynesian Islands by the travellers and naturalists employed by the brothers Godeffroy of Hamburgh. These gentlemen not only have extensive collections *made*, but also trouble themselves to get them properly *worked out*. The excellent volume on the ornithology of the Fiji, Samoa, and Tonga Islands, published in 1867 by Drs. Finsch and Hartlaub, is based entirely upon materials thus obtained, as are likewise the many capital memoirs which fill the parts of the illustrated quarto *Journal der Museum Godeffroy*—a journal replete with information upon the geography, ethnography, and natural history of Polynesia. Amongst these memoirs I must call special attention to Dr. Günther's "Fische der Sudsee," founded upon Mr. Andrew Garrett's splendid collection of fishes and of drawings of them, coloured from life, of which three parts are already issued. We have now almost for the first time the after opportunity of becoming acquainted with the exceeding beauty of the tropical fishes in life.

The late Mr. Julius Brenchley's account of his cruise in H.M.S. *Curaçoa* among the South Sea Islands, and published in 1873, contains an appendix of "Natural History Notices," illustrated by figures of remarkable specimens obtained on the occasion. Of these the part relating to the birds is by the late Mr. G. R. Gray, and those concerning the reptiles and fishes by Dr. Günther.

3. THE SANDWICH ISLANDS.

The Sandwich Islands stand apart zoologically as geographically from the rest of Polynesia, and merit more special attention than has yet been bestowed upon them. Of their birds, which form the most prominent part of their vertebrate fauna, Mr. Dole has given a synopsis in the "Proceedings of the Boston Society of Natural History." In noticing this paper in the "Ibis" for 1871, I have introduced some supplementary remarks upon the general facies of the Avifauna.

CONCLUSION.

In concluding this address, which has extended, I regret to say, to a much greater length than I anticipated when I selected the subject of it, I wish to endeavour to impress upon naturalists the paramount importance of locality.

In the study of distribution more probably than in any other direction, if perhaps we except embryology, will be ultimately found the key to the now much vexed question of the origin of species. The past generation of naturalists could not understand the value of locality. A museum was regarded as a collection of curiosities, and so long as the objects were there it little mattered in their eyes whence they came. The consequence is that all our older collections, and even, I regret to say, our national collection itself, are filled with specimens utterly without a history attached to them, unless it be that they were purchased of a certain dealer in a certain year. Even in the present generation it is only the more advanced and enlightened thinkers that really understand the importance of locality. It is with the hope of impressing the value of locality and distribution more firmly upon you that I have devoted my address not to the general progress of biology, but to the present state of, and recent additions made to, our knowledge of the geographical distribution of the Vertebrata.

Dr. Carpenter, in moving a vote of thanks to the President for his address, said its value would only be fully appreciated by the working naturalist studying and consulting it in the prosecution of his researches. Such a stock-taking was of the highest value in guiding to the right study of what was known, and in laying bare deficiencies. Within a few years the subject of geographical distribution had arisen to great dimensions, both in relation to the origin of species and to the changes in the earth's surface since the present distribution of life had been approximately attained. Any single fact with regard to distribution had its value, but accuracy was vital; as he proceeded to show. The different species of fresh-water fish in Swiss lakes were now regarded as modifications due to differences of food, temperature, bottom, &c., having their slow effect in developing races since the time when the various waters were in communication, and if changes were admitted to such an extent in our existing fauna as the result of plain causes, it was legitimate to argue that much greater changes might have taken place in the ages of geological time.—Professor Allman spoke of the increased importance of all the results of exploration since the promulgation of the doctrine of descent, which was now almost universally accepted in one form or another.—Professor Rolleston said that Dr. Sclater's paper on Geographical Distribution had come out in 1858, before Messrs. Darwin's and Wallace's papers had been published; and yet what he had laid down in 1858, he had in no important points had to modify. He did not know of any biological doctrines that had undergone so little change since that period.—Dr. Sclater announced that he proposed to add an appendix to his address, containing the full titles of all the works he had referred to.

Department of Zoology and Botany.

Professor Newton read a paper "On certain neglected subjects of ornithological investigation." He said that it seemed to him that ornithologists had been getting into certain well-worn ruts, to the abandonment of other tracks which were well worth travelling upon. He had recently had occasion to take stock of our present ornithological knowledge, and on the whole the result was gratifying. Some departments had received an enormous impetus from the doctrines of evolution, and that impetus would continue and would probably be increased. Some years ago there was a very general disposition to cry down species-mongers, as they were called in opprobrium; but it was a very short-sighted view; and in his opinion they were having their revenge, for their work had now a value far above that which it had in the Pre-Darwinian days. The result of labours on geographical distribution was good, and was gradually helping to build the edifice of evolution; not that the edifice was erected yet; its walls were still far from complete. Yet he thought its completion was about as sure as anything well could be. The subject of what he might call developmental osteology, in which the illustrious name of Parker stood practically alone, was one in which it might truly be said that the harvest was plenteous and the reapers few. There was room for a score of Parkers; yet it was no more likely that they would get them than that they would get a score of Shakespeares. Fossil ornithology had not as yet produced very great results, but descriptive anatomy was in a fairly good condition, although he was afraid that a great many skilled observers of the outsides of birds knew very little about it. As to pterylography, he feared it was not very much thought of, and that a vast majority of ornithologists did not know the meaning of the word. He recommended all to read the translation of Nitzsch's great work on the subject in the Ray Society's publications. He noticed the greatest falling-off in observational ornithology. They had outdoor ornithologists by dozens, all going on in exactly the same way as their predecessors, each trying to find out the same facts for himself; so that they were almost at a standstill, especially on the subject of the migration of birds. Observers were content not to do anything more than had been done by Gilbert White, forgetting that he had had to prove or disprove the fact of migration, about which there was no question now. We wanted to know something of the causes of migration and of the faculties by which it was performed. Hundreds of records of dates of arrival of birds would bring us no nearer to these discoveries. He thought a digestion and collation of the immense mass of facts on these subjects already existing in Great Britain was wanted, such as had already been prepared for Germany; but one thing that would *not* come of it, he was persuaded, was an answer to the questions he had indicated. There was great want of information as to the routes taken in migration, and also as to the facts of partial migration. He thought they must look in this direction for the solution of the larger question. It would be very enlightening if they could know something of the reasons which induced the migration of the majority of individuals of a species, leaving some behind. It had been suggested by Dr. von Middendorff that probably birds in their migrations were guided by a knowledge of the situation of the magnetic pole; and however much they might disbelieve that, they had really no facts which could controvert that or any other wild theory on the subject. As to birds learning the way by experience, and by the teaching of those who had traversed the route before, that would not explain migrations which took place by night, or over a thousand miles of sea. The laws of plumage and of moulting were little known, and might with advantage be studied by those who had constant access to zoological gardens, such as those at Clifton. The duration of the periods of incubation of birds was almost unknown, as well as the reasons for the variations. Nothing was known for certain as to the effect of variations of atmospheric temperature or other conditions in shortening or lengthening the period. Out of more than 200 species of British birds, the duration of incubation was known in only about twenty; and of foreign birds even less was known. He could mention other branches in which knowledge was deficient, but perhaps what he had said would be sufficient to induce some of those who had not adopted any special branch of study to prosecute some of the inquiries he had recommended. The good workers at present labouring were fully occupied with important subjects. He could not expect that they would be able to divert their attention from their chosen departments.—In the discussion which followed, Canon Tristram remarked on the ease with which many who go abroad for the winter or summer might make valuable records of the time of arrival or the latest time of seeing migratory birds. Mr. Elwes urged on country clergymen the valuable service they might easily render by taking ornithology as a recreation; much was lacking in regard to osteology and nidification; skins were too much attended to. Mr. Bettany urged the study of Mr. Parker's papers on all ornithologists who could make themselves capable of comprehending them, in order to prepare the way for a better understanding of the genetic affinities of birds in the future; and also mentioned the service that might be done to such men as Mr. Parker by any naturalist who would collect a series of specimens from the earliest to the adult stage of any single species, and preserve them for study by such an authority.

On the reading of the report on the Zoological Station at Naples, which we have abstracted elsewhere, Mr. Spence Bate said it was greatly to be desired that such schools of study should be established in Great Britain. He did not think they should have to go to Naples for one. They should be attached to the various aquariums now being established.

Dr. C. T. Hudson read an able paper, the result of many years' study, on the classification and affinities of the Rotifera. It was illustrated by a large number of beautiful magnified drawings of their anatomy, bearing testimony to the industry and ability of the author. He commenced by discussing Ehrenberg's classification, and showed that its fundamental principles were erroneous, for it was based on a supposed structure of the trochal disc which did not really exist, on a forced interpretation of the term lorica, and on the presence, absence, and number of certain red spots, which Ehrenberg took for granted as eyes, but which were not always so. Moreover, those that really were eyes were often present in the young animal, but invisible in the adult. Ehrenberg's symmetrical system brought together widely dissimilar forms, and separated those that were intimately connected. Not a single Rotifer, as far as the author could find, properly came under Ehrenberg's Monotrocha. A new Melicerta had been found, that did not make a tube; and his Sorotrocha included every form of head. There was no such thing really as a Holotrochous form. The systems of Leydig and Dujardin were then examined and shown to be inferior to Ehrenberg's, though it was pointed out that each naturalist had contributed a happy idea, the former having brought into prominence the great value of the foot as a characteristic for classification, the latter having the thought of classifying the Rotifers by their mode of locomotion. Dr. Hudson then proceeded to offer a natural classification, using the best results of preceding observers, based on the habits, teeth, water, vascular and nervous systems. There were four great groups, subdivided into families. (1) *Rhizota*, the permanently attached forms, all having teeth of the same pattern, including the Floscularina and Melicertidæ; (2) *Bdelloida*, those that swim and creep like a leech, including the Philodinidæ, the lowest and most worm-like forms; (3) *Ploïma*, or free-swimmers, including Brachionidæ, Pterodinidæ (a new genus and species of his own), Euchlanidæ, and Notommatina; (4) *Scirtopoda*, or jumpers, including Pedalionidæ, and Synchætidæ. As to the affinities of the Rotifers, while giving up Philodinidæ to the Vermes, he advanced numerous reasons for believing that the other Rotifers were allied to Entomostracans, and ought to be classed with them. He claimed to have destroyed some of the arguments of Professor Huxley on this point, by finding male forms which had been previously unknown, and among them the male of *Lacinularia socialis*, the very species taken as the text of Professor Huxley's remarks on the whole class. The resemblance of Pedalion to some Entomostracous larvæ was insisted on, as also its connection by other aberrant rotifers with those of typical form.—Mr. Spence Bate spoke highly of the labour and skill which Dr. Hudson had spent upon this class, but he must say that in regard to the affinities of Rotifera the evidence brought forward had been such as to convince him most conclusively that they were *not* related to the Crustacea.

On the Primary Divisions of the Chitonidæ, by P. P. Carpenter, B.A., Ph.D., Montreal.—He divided them into articulated or perfect, and non-articulated or imperfect; each of these were naturally divided into regular and irregular. The Palæozoic Chitons were all imperfect, and culminated in the Carboniferous period; very few are now living. The Neozoic epochs gradually developed perfect Chitons which culminate at the present time. The writer sought information as to unusual forms, recent or fossil, to be posted to 508, Guy Street, Montreal.

Department of Anatomy and Physiology.

ADDRESS BY PROFESSOR CLELAND, M.D., F.R.S., VICE-PRESIDENT.

I shall not venture to occupy the time of the Section with any *résumé* of the work done in anatomy and physiology during the past year, as such information is readily accessible in the pages of journals and year-books. I shall content myself with making some comments on the condition of anatomy at the present time in a few important particulars.

I had intended to speak also of some subjects connected with physiology; but I find that I cannot do so without lengthening my remarks to a greater extent than might be desirable. I shall be content, therefore, so far as that science is concerned, to mention that, although experimental physiology is probably less cultivated in this country than in any other in which biology is studied, it has been practically decided by Parliament that it is quite time to put some check on investigation in that direction; for, as everyone knows, a Royal Commission has been appointed to inquire into vivisection. In the scientific world all are agreed, whatever opinions may prevail in other sections of the community, that the man who would wantonly inflict pain on a brute beast is himself a brute, and deserving to be roughly handled; and because there is no difference of opinion on that subject, and because no experimental science can well prosper if one man is to judge for another what experiments are justifiable to institute or to repeat, or are likely to give important results, I do deplore the clamour which well-meaning persons have raised, and regret that it has been so far yielded to.

In anatomy the most important progress in recent years has been made in those departments which abut most closely on physiology, namely, the microscopy of the tissues and development. The whole conception of the nutrition of the body has become altered in comparatively recent years by the additions to our knowledge of the nucleated corpuscles, which are the living elements of which it is composed; and principally by the recognition of the secondary nature of cell-walls, the close connection or even continuity of the nerves with other textures, and the identity of the white corpuscles of the blood with amœboid or undifferentiated corpuscles outside the vessels. The origin of every living corpuscle from corpuscles pre-existing is no longer difficult to imagine, but may, I incline to think, be almost looked on as proved. The history of each may be traced back through conjugated germs to the corpuscles of preceding generations in uninterrupted succession, and the pedigree of the structural elements is seen to differ in no way from that of individual plants or animals. It is true, indeed, that no absolute proof exists that new living corpuscles originating by mere deposit are not added to the others; but the evidence against such a thing taking place is exactly of the same description as that which exists against spontaneous generation of independent organisms, namely, that things previously unexplained by the theory of parentage are explained now, while, on the other hand, there is no sufficient evidence of the origin of life by any other mode.

Leaving histology (he said), I shall devote the rest of my remarks to the morphology of the *Vertebrata*. Here I am less disposed to indulge a gratulatory vein. No doubt within the last dozen years we have had work to be grateful for. Worthy of a prominent place in this, as in other departments of anatomy, is the encyclopædic work, the "Leçons," of Milne-Edwards, invaluable as a treasury of reference to all future observers; while the memoirs of Gegenbaur on the carpus, on the shoulder-girdle, and on the skulls of Selachian fishes, and Kitchen Parker's memoirs devoted to mature forms, may be taken as examples that morphological problems suggested by adult comparative anatomy have not lost their attraction to men capable of elaborate original research. And I the more willingly select the names of these two writers, because on one subject on which they have written, the shoulder-girdle, I am compelled to differ from their conclusions and to adhere rather to those of Owen, so far as the determination of the different elements in fishes is concerned; and by stating this (although the subject cannot be now discussed) I am enabled to illustrate that the appreciation of the value of elaborate and painstaking work is a matter totally distinct from agreement with the conclusions which may be arrived at in the investigation of complicated problems, although wisdom and penetration as to these must ever command admiration.

But when one looks back on the times of Meckel and Cuvier, and on the activity inspired by the speculations of the much-abused Oken, the writings of Geoffroy St.-Hilaire, the less abstrusely speculative part of the works of G. C. Carus, and the careful monographs of many minor writers; when one reflects on the splendid grasp of Johannes Müller, and thinks of the healthy enthusiasm created in this country for a number of years by Owen's "Archetype and Homologies of the Vertebrate Skeleton," and then contemplates the state of vertebrate morphology at the present moment, it seems to me that its homological problems and questions of theoretical interest do not attract so much attention as they did, or as they deserve.

The Origin of Species by Natural Selection.

There can be no doubt that a great and curious influence has been exercised on morphology by the rise of the doctrine of the origin of species by natural selection. Attention has been thereby directed strongly for a number of years to varieties, and probably it is to this doctrine that we owe the larger number of observations made on variations of muscles, nerves, and other structures. Particularly elaborate have been the records of muscular variations, very praiseworthy, interesting to the recorders, very dry to most other people, and hitherto, so far as I know, barren enough of any general conclusions. So much the more credit is due to those who have worked steadily in faith that beauty will emerge to gild these results some day.

But the doctrine of natural selection has had a further effect in anatomical study, aiding the reaction against the search for internal laws or plans regulating the evolution of structures, and directing attention to the modifying influences of external agencies. This effect has happened naturally enough, but it has been far from just; rather is it a pendulum-like swing to another extreme from what had previously been indulged in. The doctrine of natural selection starts with the recognition of an internal formative force which is hereditary; and in the development of the doctrine, the limits of hereditary resemblance have been greatly studied; and further, it will be observed that one of the fundamentals of the doctrine is, that the formative force alters its character gradually and permanently when traced from generation to generation in great tracts of time. Now I am not going to enter on a threadbare discussion of the origin of species in this company; suffice it to say that, while the existence and extensive operation of such a thing as natural selection seems to have been convincingly proved, it is a very different thing to allege that it has been the sole, or even the principal agent in producing the evolutions of living forms on the face of the earth. So far as anatomy is concerned, it is a secondary matter whether the link between the members of the evolving hosts of life have been genetic or not. But I wish to point out that, even pushing the Darwinian theory to the utmost possible extreme, the action of external agents infers the existence of something acted on; and the less directly they act, the more importance must be given to the hereditary or internal element. We are therefore presented with a formative force, which exhibited itself in very simple trains of phenomena in the first beginnings of life, and now is manifested in governing the complex growth of the highest forms. We are set face to face with that formative force, and are obliged to admit its inherent capability of changing its action; and that being the case, is it more of an assumption to declare that the changes are all accidental and made permanent by accident of external circumstances, or to consider that it has been the law proper to this force to have been adequate to raise forms, however liable to modification by external circumstances—to raise them, I say, from the simple to the complex, acting through generations on the face of the earth, precisely as it acts in the evolution of a single egg into an adult individual? This is that formative force which has been elaborately shown by Mr. Darwin, in launching his theory of "pangenesis," not only to be conveyed through whole organisms and their seed, but to pervade at all times the minutest particles of each; and I merely direct attention to the fact that its extension over the whole history of life on the globe must be granted, and ask if, in the range of forms which furnish at the present day an imperfect key to the ages which are past, there is not exhibited a development comparable, in its progression to definite goals, with what is shown in the life of a single plant or animal. For my own part, I am fully convinced of a unity of plan running through animal forms, and reaching, so far as the main line is concerned, its completion in the human body. I confess that I think that there is evidence that animal life has reached its pre-ordained climax in humanity; and I cannot think it likely that, as myriads of years roll on, descendants differing *in toto* from man will be developed. To argue the subject would be to enter on the largest subjects of morphological anatomy, and on speculations on which agreement could not be expected. Even, however, in the nature of the variations in the human race there seems to be some evidence that the progress of evolution is to be traced from man, not to other animal forms yet to appear, but, through his physical nature, into the land of the unseen. Those variations, keeping out of view differences of bulk and stature, which appear to have some relation to geographical position, are principally to be found in the head, the part of the body most closely connected with the development and expression of the mental character; and I may mention that when, some years ago, my attention was directed to the variations of the skull, the only part whose variations in different races I have had opportunity of studying with any degree of minuteness, I became satisfied that in uncivilised races there might be distinguished skulls which had undergone hereditary degeneration, others which had reached the most advanced development possible for them, and a third set, notably the Kaffirs, with large capabilities for improvement in the future. Indeed it is beyond doubt that there is a limit for each type of humanity beyond which it cannot pass in the improvement of the physical organisation necessary for mental action.

There are also some curious indications in human structure of the formative force nearing the end of its journey. In the details of the skeletons of other animals one sees the greatest precision of form; but there are various exceptions to this neatness of finish in the skeleton of man, and they are found in parts specially modified in connection with the peculiarities of his development, and not requiring exactness of shape for physiological purposes; while, on the other hand, physiognomical mould and nicety of various physiological adaptations are found in perfection. Look at the variations in the breast-bone, especially at its lower extremity, which is never shapely, as it is in the lower animals. Look at the coccygeal vertebræ; they are the most irregular structures imaginable. Even in the sacrum and in the rest of the column the amount of variation finds no parallel in other animals. In the skull, except in some of the lowest forms of humanity, the *dorsum sellæ* is a ragged, warty, deformed, and irregular structure, and it never exhibits the elegance and finish seen in other animals. The curvature of the skull and shortening of its base, which have gradually increased in the ascending series of forms, have reached a degree which cannot be exceeded; and the nasal cavity is so elongated vertically, that in the higher races nature seems scarcely able to bridge the gap from the cribriform plate to the palate, and produces such a set of unsymmetrical and rugged performances as is quite peculiar to man; and to the human anatomist many other examples of similar phenomena will occur.

Questions of homology are matters which must be ever present in the study of structure, as distinct from function—both the correspondence of parts in one species to those in others, and the relations of one part to another in the same animal; and perhaps I shall best direct attention to the changes of opinion on morphological subjects in this country during the last twenty-five years by referring shortly to the homological writings of three eminent anatomists—Professors Owen, Goodsir, and Huxley.

Changes of Opinion on Morphological Subjects.

For the first time in English literature the great problems of this description were dealt with in Prof. Owen's work already referred to, published in 1848; and it is unnecessary to say that, notwithstanding the presence of unquestionable errors of theory, that work was a most valuable and important contribution to science. The faults in its general scope were justly and quietly corrected by Goodsir at the meeting of this Association in 1856 in three papers, one of them highly elaborate; and in these he showed that the morphology of vertebrate animals could not be correctly studied while reference was made exclusively to the skeleton. He showed the necessity of attending to all the evidence in trying to exhibit the underlying laws of structure, and especially of having constant regard to the teachings of embryology. Among the matters of detail which he set right it may be mentioned that he exposed the untenability of Prof. Owen's theory of the connection of the shoulder-girdle with the occipital bone, and pointed out that the limbs were not appendages of single segments corresponding with individual vertebræ. Referring to the development of the hand and foot, he showed the importance of observing the plane in which they first appear, and that the thumb and great toe are originally turned towards the head, the little finger and little toe toward the caudal end of the vertebral column. But he probably went too far in trying to make out an exact correspondence of individual digits with individual vertebral segments, failing to appreciate that the segmentation originally so distinct in the primordial vertebræ becomes altered as the surface of the body is approached—a truth illustrated in the vertebral columns of the plagiostomatous fishes, in the muscle-segments over the head in the pleuronectids, and in the interspinal bones bearing the dorsal and anal fin-rays of numbers of fishes, but, so far as I know, not hitherto sufficiently appreciated by any anatomist.

In 1858 Prof. Huxley delivered his Croonian Lecture on the vertebrate skull, and in 1863 his lectures at the Royal College of Surgeons on the same subject. He profited by the wisdom of Goodsir, and studied the works of Rathke, Reichert, and other embryologists. But, rightly or wrongly, he took a step further than Goodsir. He assumed from the first that the homologies of adult structures could be determined by development, and that by that study alone could they be finally demonstrated. As regards the skull, the constitution of which always remains the central study of the vertebrate skeleton, his writings marked the introduction of a period of revulsion against not only the systems of serial homologies previously suggested, but even against any attempt by the study of the varieties of adult forms to set them right. Mr. Huxley has added materially to the previously existing number of interpretations as to what elements correspond in different animals, and in doing so has found it necessary to make various additions to the already troubled nomenclature. Those who consider these changes correct will of course see in them a prospect of simplicity to future students; but to those who, like myself, have never been able to agree with them, they are naturally a source of sorrow. Among the changes referred to may be mentioned the theory of the "*periotic bones.*" That theory, I venture to think, a very unfortunate one, introducing a derangement of relations as widespread as did Goodsir's theory of the frontal bone. And do not think me presumptuous in saying so, seeing that this theory is in antagonism with the identifications of every anatomist preceding its distinguished originator, not excepting Cuvier and Owen; nor is it easy to discover what evidence it has to support it against the previously received decision of Cuvier as to the *external occipital* and *mastoid* of fishes. Without entering into the full evidence of the subject, it may be stated that, so far as this theory affects the *alisphenoid* in the skull of the fish, it must be given up, and the determination of Prof. Owen must be reverted to, when it is considered that in the carp the third and fourth nerve pierce what that anatomist terms the *orbitosphenoid*, the bone which is *alisphenoid* according to the theory which terms the *alisphenoid* of Owen the *prootic*. A proof still more striking is furnished by *Malapterurus* and other Silurids, in which the bone in question is pierced by the optic nerve. That being the case, the prootic theory will be seen to have arisen partly from giving too much importance to centres of ossification, and partly from considering the nerve-passage in front of the main bar of the *alisphenoid* of Owen as corresponding with the *foramen ovale* of man rather than with the *foramen rotundum* and sphenoidal fissure. A spiculum, however, separating the second from the third division of the fifth nerve, and having therefore the precise relations of the mammalian *alisphenoid*, does exist in the carp and other fishes. But in reptiles Prof. Huxley's determination of the *alisphenoid* is right, and Prof. Owen's clearly wrong; for in the crocodile the *alisphenoid* of Huxley and others is perforated by the sixth nerve, so that it cannot have any claim to be called *orbitosphenoid*. I must, however, maintain, against Prof. Huxley's view, Prof. Owen's determination of the *nasal* in fishes, notwithstanding that Prof. Owen has failed to appreciate the exact relation of that bone to the nasals of mammals, and has thereby laid his position open to attack. The arguments on that point Prof. Huxley was good enough to lay before the public fourteen years ago, by kindly reading for me before the Royal Society a paper which subsequently appeared in its "Transactions;" and I am not aware that anyone has since attempted to controvert them.

I shall not trouble you further with such matters of detail; but it will be clear from what has been said that the beginner in comparative anatomy must at the present day find himself at the outset, in the most important part of his osteological studies, faced with a diversity of opinion and confusion of nomenclature sufficient to produce much difficulty and to have a repelling effect on many minds. Such difficulties might well be encountered with enthusiasm where a belief existed that behind them lay a scheme of order and beauty; but not many will spend time in investigating such intricate details if they doubt the interest of the general conclusions likely to be reached by mastering them. On this account it is a great pity that the scepticism generated partly by the difficulties of the subject, and partly by reaction from the dogmatism of the admirers of Oken, does too frequently discourage the investigation of the serial homologies of the parts entering into the segments of the skull, and the determination of the nature and number of those segments. It is a pity that so much clamour has been made for a number of years against the expression "vertebral theory of the skull," because fighting against words is but stupid warfare at the best, and because all that was really meant, and could be justly stated, could have been brought into prominence without objecting to a time-honoured phrase. It is questionable if anyone who ever used the convenient term "vertebral theory" meant to indicate more than a certain community of plan on which were built the segments of the skull as well as those of the spinal column; that, in fact, the two constituted one complete chain, of which the first few segments were so different from the rest, that till Oken pointed the fact out, it was not recognised that they were segments lying in lineal continuity with the rest. But the matter has recently stood thus:—that to some minds, in the imperfect state of our knowledge, one thing seemed essential to a segment comparable to the rest, and to others something else seemed requisite; and the oddity of the position of affairs is this, that the objectors to the phrase "vertebral theory" have been as crotchety in setting up imaginary essentials to a segment as their neighbours. On the one side we were taught to expect certain definite osseous elements in each segment, to which definite names were given; while, on the other, in opposition schemes, centres of ossification have been built on as matters of primary consequence, although a glance at the modifications in the vertebral column proper might convince anyone that they are things of the very slightest importance morphologically. Also those who have objected to speaking of cranial vertebræ have put great importance on the point at which the *chorda dorsalis* terminates, although it has been long known that in one animal the *chorda dorsalis* runs right on to the front, that in others it fails to enter the skull at all, while in the majority it passes for a certain distance into the base. Johannes Müller, on such grounds, concluded thirty years ago that the presence of *chorda dorsalis* was not necessary to constitute a cranial vertebra; and there seems no reason to doubt that he was right. Looking at the early embryo, the cerebro-spinal axis is seen to be one continuous structure; and the walls of the canal containing it are likewise manifestly continuous, not at first distinguishable into a spinal and a cranial portion. Looking at the adult condition, in the higher classes the vertebræ of the tail are seen dwindling into mere bodies developed round the *chorda*, and giving off rudimentary processes without separate centres of ossification, while towards the head the bodies diminish and the arches enlarge; and in the skull the *chorda*, round which the bodies in the rest of the column are developed, comes to an end, and the neural arches are enormously enlarged and have additional centres of ossification, precisely as in the mammalian thorax costal centres of ossification are found which do not exist in the costal elements of cervical vertebræ. It would therefore be quite as justifiable to object to the term vertebra as applied to a joint of the tail because it has no *laminæ*, or none with separate centres of ossification, as to object to its applicability to segments of the skull because the *chorda* is absent, or the osseous elements different in number from those found usually in the segments of the trunk.

However, it is gratifying to observe that among the most recent additions to morphological anatomy there is a highly suggestive paper by Prof. Huxley, appearing in the Royal Society's "Proceedings" for December last, and entitled "Preliminary Notes upon the Brain and Skull of *Amphioxus lanceolatus*," in which the learned Professor, who has for many years been the most determined opponent to the mention of cranial vertebræ, declares, so far as I can apprehend his meaning, that the region of the head represents no less than fourteen segments, all of which he terms *protovertebræ* in *Amphioxus*. This determination of correspondences is made the more remarkable by being followed up with a suggestion that the numerous protovertebræ lying in front of the fourteenth in *Amphioxus* are represented only by muscles and nerves in the higher vertebrates.

I hail this paper as being practically at last an ample acknowledgment that there is no escape from admitting the correspondence of the region of the head with the segments of the trunk: but the details of the new theory scarcely seem convincing; and I might have preferred to leave its discussion to others, were it not that the notions which it opens up are far too important to allow it to be passed over in any account of the present state of opinion on the subject of vertebrate morphology. The argument in this new theory runs thus: that the palate-curtain of *Amphioxus* is homologous with that of the lamprey, and that the palate-curtain of the lamprey is attached below the ear; that therefore all the seven segments seen in front of the palate-curtain of *Amphioxus* are represented by parts in front of the ear in the lamprey and the other Vertebrata. Again, the branchial arches of the higher Vertebrata are assumed to be of the nature of ribs, and in none of the Vertebrata next above *Amphioxus* "are there more than seven pairs of branchial arches, so that not more than eight myotomes (and consequently protovertebræ) of *Amphioxus*, in addition to those already mentioned, can be reckoned as the equivalents of the parachordal region of the skull in the higher vertebrates." Everything, observe, depends on the segment to which the palate-curtain of *Amphioxus* belongs. Now I have already pointed out to you that the segmentation of the vertebrate body is not perfect; and there is no method by which the alimentary canal, of which the mouth and palate are the first part, can be divided into segments corresponding with the cerebro-spinal nerves. Most certainly we cannot judge that a portion of a viscus belongs to a particular segment from its lying underneath some other structure in definite relation, like the ear, to the cerebro-spinal system; for then should we be obliged to grant that one-half or more of the heart belongs to segments in front of the ear, since it is undoubtedly so situated in a chick of the thirty-sixth hour. But the branchial arches are in front of the heart, and, according to the theory which we are considering, are behind the ear; thus the principle assumed in the starting-point of the theory is taken away.

Again, it is important to observe that the branchial skeletal arches cannot be ribs, for they lie internal to the primary circles of the vascular system formed by the branchial arteries and veins, while the ribs are superficial to both heart and aorta. If the ribs are represented at all in the branchial apparatus (and I doubt it very much), it is by the cartilages superficial to the gills in sharks, rays, and dog-fishes; and it would seem impossible for anyone who has dissected them to doubt that those cartilages are homologous with the branchial skeleton of the lamprey, which they somewhat resemble. In fact, if the external and internal branchial openings of the lamprey be enlarged, its gills are reduced to a form similar to those of the shark.

There is nothing in this, however, which interferes seriously with the proposed theory of the skull. It is merely a point in the argument which I have thought right to clear. More important it is to remark that, on the supposition that numerous protovertebræ are represented in the region of the head, there are most serious difficulties interfering with the idea that they are, as Prof. Huxley states, "represented only by muscles and nerves in the higher Vertebrata," and that there is any correspondence between "the oculo-motor, pathetic, trigeminal, and abducens nerves with the muscles of the eye and jaws" and the regular nerves and muscle-segments of the fore part of *Amphioxus*. Even in the lamprey the eye-balls are supplied with muscles similar to those to which, in other vertebrates, the oculo-motor, pathetic, and abducens are distributed; and I find in the large species that, notwithstanding this, the series of regular muscle-segments is continued over the head, not indeed in the same way as in *Mixine*, but in a highly instructive and curious manner. After further dwelling upon this point, Prof. Cleland said:—

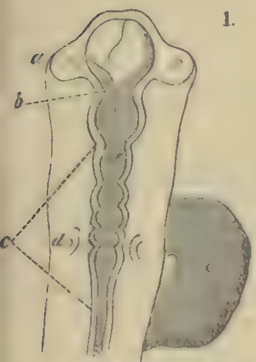
It may be noticed as a wholesome symptom in anatomical speculation, that the new theory which has led to these remarks is founded on arguments drawn altogether from comparison of different species, and not from embryology, a very remarkable circumstance as coming from one who so lately as last autumn reiterated in this Section his slowness to believe in reasonings founded on adult forms, and even on "later development." The wisest know so little, that humanity must be content to gather information from every possible source, and leave no set of ascertained facts out of view in attempting to arrive at generalisations. If we had before us all the adult anatomy of every species that ever lived on the earth, we should only then have the record completed from which to frame a full system of morphology; and as matters stand we must translate embryological phenomena with the aid of the series of adult forms, as well as translate the teachings of the adult series with the aid of embryology.

Falling back on my proposition, that the segments of the vertebrate body are nowhere complete, and that segmentation at one depth may exist to a greater extent than at another, I may mention certain embryological phenomena in the brain, which have received too little attention, and which to some extent warrant belief in a larger number of segments in the head than is usually admitted; although I do not see that they are necessarily at variance with that theory of seven segments in every ossified skull which I indicated in 1862. In the chick, in the middle of the second day of hatching, already is the third cerebral vesicle divided into a series of five parts, separated by slight constrictions, the first part larger than those which succeed, and the last part narrowing to the spinal cord. The auditory vesicle lies opposite the constriction between the fourth and fifth parts. At the end of the second day and during the third, these divisions assume dimensions which give them a general appearance exceedingly similar in profile to the protovertebræ of the neck. In the following day they exhibit a more complex appearance, and after that the first compartment alone remains distinct as cerebellum, while the divisions between the others disappear in the thickening of the cerebral walls. In their first two stages, Mr. Huxley, whom I have already referred to so often, has figured these crenations, but he has not, so far as I know, described them.

I may also direct attention to another embryological point, to which I referred last year at Belfast as a probability. I speak now from observation. That which is termed the first cerebral vesicle in the early part of the second day of hatching of the chick, is an undifferentiated region of the brain from which a number of parts emerge successively from behind forwards. As early as the thirty-sixth hour the optic nerves can be traced, separated from the rest of the vesicle by distinct elevations of the floor of the brain, reaching inwards to the constriction between the first and second vesicles: and as early as this date the first trace of bifidity of the brain in front may be discerned—

that bifidity which, to my thinking, is only one of several instances of longitudinal fission in the fore part of the head, the trabeculæ presenting another instance of the same thing, and the cleft between the maxillary lobe and the part of the head above it a third; while in the muscular system such longitudinal cleavage or fission is common even in the trunk. In a chick of the third or fourth day, when rendered very transparent, the optic nerves can be seen extending from beneath the front of the optic lobes; while in front of the optic lobes there are placed in series from behind forwards a posterior division of the first vesicle, an anterior division, the cerebral hemispheres, and the olfactory lobes. Thus there is a large supply of material presented in the brain for the study of segmentation; the difficulty to be overcome by future inquiry and careful collation of all available facts is to determine the value of the parts placed one in front of another.

1.



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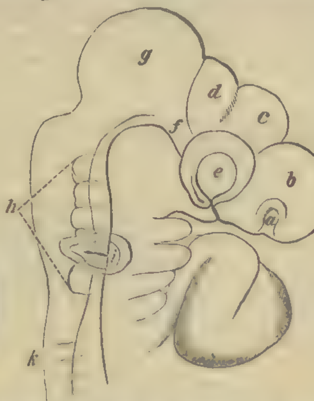

FIG. 1.—Embryo chick of 36 hours. *a*, primary optic vesicle; *b*, optic commissure; *c*, third cerebral vesicle; *d*, ear; *e*, heart.

FIG. 2.—Chick three days old. *a*, nostril; *b*, hemisphere; *c*, *d*, divisions of first cerebral vesicle; *e*, eye; *f*, optic nerve; *g*, optic lobe; *h*, crenations of third cerebral vesicle; *i*, ear; *k*, first primordial vertebra.

Perhaps I have occupied time too long with matters involving a large amount of technical detail; but I trust that I may have, in some measure, illustrated that both in aim and in accomplished work anatomy is no mere collection of disconnected facts, no mere handmaid of the physician and surgeon, nor even of physiology. I do not doubt that it is yet destined, as dealing with the most complex sequences of phenomena, to take the highest place among the sciences as a guide to philosophy. One cannot help noticing the increased importance now given to Natural History studies as a part of education; and it is worth while to note that it is most of all in anatomy and physiology that the close connections of matter with mind are brought under review,—physiology exhibiting the relations of our own mental being to our bodies, and anatomy revealing a body of organised nature, whose organisation points to a source of beauty and order beyond.

3.

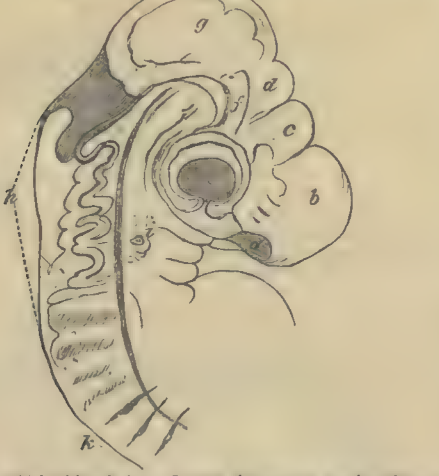

FIG. 3.—Chick of fourth day. Letters the same as previous figure.

The people of Bristol do well to rally round their Medical School. They do well to furnish it with buildings suitable for the prosecution of all the Natural History studies which adhere to medical education; and they do well to join with that school a complete college of literature and science. Let us hope that they will make it worthy of so wealthy and historic a city. But if they will have their medical school the success which in so flourishing a locality public enthusiasm may well make it, and if they will have it aid as well as be aided by a school of general education, let them follow the system latterly adopted in Oxford and Cambridge, long carried out in the Universities of Scotland, and recognised, though not in all instances sufficiently provided for, in Ireland. Let anatomy, human and comparative, receive its place as an important and fundamental science. Let thorough and adequate provision be made for its being taught as a science; and see that it do not, as in too many medical schools which shall be nameless, degenerate to the etymological and original meaning of the word, a mere cutting up of carcases.

Mr. H. B. Brady exhibited a series of micro-photographs chiefly from physiological and pathological preparations, taken by a new and simple process, devised by Mr. Hugh Bowman, of Newcastle. The apparatus was also shown and described. It consisted of a simple mirror of speculum metal, placed at an angle of 45 degrees in front of the eye-piece of the microscope, and directed downwards. The image was received upon a collodion plate set in the frame of a common photographic camera, and the photograph taken in the usual way. About 11 seconds was stated to be a sufficient exposure for the purpose.

A paper was read by Dr. Martyn entitled *Some New Researches on the Anatomy of the Skin.* Dr. Martyn had discovered that the cells which appeared "spinous" or "echinate," when isolated from their connection, if they could be at any time seen in single layers, were simply united together by delicate bands. These are so constantly seen broken across that they assume the form of tubercles or "prickles." As repeated observations confirmed this, the name "conjoined epithelium" had been proposed for this form or stage in the cell life.

A paper *On the Physiological Action of the Chinoline and Pyridine Bases*, by Dr. J. G. M'Kendrick and Prof. Dewar, was read by the former gentleman. The following are the general conclusions arrived at:—1. There is a marked gradation in extent of physiological action of the members of the pyridine series of bases, but it remains of the same kind. The lethal dose becomes reduced as we rise from the lower to the higher. 2. The higher members of the pyridine series resemble in physiological action the lower members of the chinoline series, except (1) that the former are more liable to cause death by asphyxia, and (2) that the lethal dose of the pyridines is less than one half that of the chinolines. 3. In proceeding from the lower to the higher members of the chinoline series, the physiological action changes in character, inasmuch as the lower members appear to act chiefly on the sensory centres of the encephalon and the reflex centres of the cord, destroying the power of voluntary or reflex movement; while the higher act less on these centres, and chiefly on the motor centres, first, as irritants, causing violent convulsions, and at length producing complete paralysis. At the same time, while the reflex activity of the centres in the spinal cord appear to be inactive, they may be readily roused to action by strychnine. 4. On comparing the action of such compounds as C_9H_7N (chinoline) with $C_9H_{13}N$ (parvoline, &c.), or $C_8H_{11}N$ (collidine) with $C_8H_{15}N$ (conia, from hemlock), or $C_{10}H_{10}N_2$ (dipyridine) with $C_{10}H_{14}N_2$ (nicotine, from tobacco), it is to be observed that the physiological activity of the substance is, apart from chemical structure, greatest in those bases containing the larger amount of hydrogen. 5. Those artificial bases which approximate the percentage composition of natural bases are much weaker physiologically, so far as can be estimated by amount of dose, than the natural bases; but the kind of action is the same in both cases. 6. When the bases of the pyridine series are doubled by condensation, producing dipyridine, parapicoline, &c., they not only become more active physiologically, but the action differs in kind from that of the simple bases, and resembles the action of natural bases or alkaloids having a similar chemical constitution. 7. All the substances examined in this research are remarkable for not possessing any specific paralytic action on the heart likely to cause syncope; but they destroy life either by exhaustive convulsions, or by gradual paralysis of the centres of respiration, thus causing asphyxia. 8. There is no appreciable immediate action on the sympathetic system of nerves. There is probably a secondary action, because after large doses the vasomotor centre, in common with other centres, becomes involved. 9. There is no difference, so far as could be discovered, between the physiological action of bases obtained from cinchonine and those derived from tar.

This paper, besides its purely scientific value, is of some interest to general readers on account of the fact discovered by Vohl and Eulenburg, that chinoline and pyridine are produced during the combustion of tobacco, and that the effects of tobacco smoking are to a great extent due to the action of these and similar bases.

Department of Anthropology.

Mr. John Evans, in moving a vote of thanks to Prof. Rolleston for his address, said it supplied the strongest evidence of the necessity for the application of the natural history method to anthropology; and the value of the study was shown by the way in which it had been brought to bear on questions of the present day.—Dr. Carpenter, in supporting the resolution, desired to refer to Dr. Prichard as a Bristol man, and because he had been mainly instrumental in directing his course at the outset of his public life; by his advice he had read his first paper before the British Association at its former visit to Bristol. His thoughts were those of a physiologist among physiologists, and a scholar among scholars, but he was resolved to keep the threads together if possible. He was perhaps the first to bring a large idea of species to bear upon the origin of man, and to trace out intermediate links and gradational characters, and to investigate the analogous features in the history of domesticated animals. With regard to the antiquity of man, he believed that Prichard was the first to propound the doctrine, now so generally accepted, of the much greater antiquity of man than could be supposed if the genealogies of Genesis were accurate. He made a careful and scientific investigation of those genealogies, and found it absolutely necessary to conclude that they could not be relied upon for chronological evidence; and when he further came to consider the amount of time necessary to produce such strongly marked races as the Jewish and the Egyptian, on the hypothesis of the unity of the race and the time which would be required to produce such divarications of language as existed in the early historical period, he was additionally supported in his view as to the antiquity of the human race.

Col. Lane Fox gave a most interesting account of recent excavations in Cissbury Camp, near Worthing, of which full details will be published at the earliest possible time. He said that the entrenchment was one of the largest in the south of England, and had all the peculiarities of a British earthwork. Camden spoke of this camp as the work of Cissa, the Saxon king of the district, from whom, in his opinion and in great probability, it derived its name of Cissbury. He believed the first notice of the place as a flint factory was by himself in 1868, when, finding a large quantity of flint flakes on the surface and a number of large pits which filled the interior of the camp on the west side, he dug into some of them to a depth of four or five feet, and found in them a still further number of flakes, together with finished and unfinished flint tools. It was evident that here was a flint factory, and that it was established because of the much greater ease of working the flints when first removed from the chalk. He had no idea then of the great extent of the mining operations of these chalk people, nor did he think it necessary to dig deeper, some of the pits as left open, and further opened by himself, being twenty feet deep. They appeared to be quite deep enough for a sufficient quantity of flints to be got. The true nature of these flint works was illuminated by accident, viz., by the cutting of a railway from Franières to Chimay, when fifty-five deep shafts of this kind were cut through, with galleries proceeding from them. In 1870 Canon Greenwell had excavated pits at Brandon, and found similar shafts and galleries. Since then Mr. Tindall, of Brighton, had opened one of the pits at Cissbury, and found a shaft thirty-five feet deep, with *Bos primigenius* and other remains of wild animals. Mr. E. Willett had excavated another twenty-five feet deep, and found galleries leading from them; and it was established that the flints did not exist so near the surface as he (Col. Lane Fox) had supposed. The question now became of great importance as to the relative age of the flint factory and the entrenchment in which it was situated. Since June last, and up to the week before the meeting of the Association, he had superintended work at these pits, aided by subscriptions from members of the Anthropological Institute. In April last he had opened a section in the ditch round the entrenchment in layers of eighteen inches to two feet, and found, in the upper layer, two oval flint implements, fragments of red earthenware, oyster shells, snail shells, bones of domestic animals, and fragments of Romano-British pottery. In the second layer there was ferruginous chalk rubble, with untouched nodules, and abundance of *Helix nemoralis*. In the third layer was found white chalk rubble, with bones of pig and ox, and oyster shells, and small fragments of British pottery. There was no indication of anything absolutely of the Roman period; any such indications were in the upper layer, and they were not conclusive. In the subsequent investigations he had been assisted by Professors Rolleston and Hughes, Mr. Harrison, and others. He saw that there were pits on the outside of the camp, that they were shallower, and that there were no flints about. He thought that if he dug out one or two nearest the entrenchment, he might see whether they were the mouths of old shafts. He found that they were so, and became satisfied that they were all shafts. Then he thought that the best means of ascertaining the relative ages of shafts and entrenchment was to dig in the ditch at the point where the line of shafts intersected the rampart. He first dug out the bottom of the ditch in layers as before, and in the second layer below the surface found fragments of Romano-British pottery, but none in the bottom layers. It was evident that this filling in of the ditch was due to the degradation of the central part of the entrenchment. It was also clear that pottery of the kind found was *not* used when the ditch was sunk. The side of the ditch sloped inwards to the west, but towards the east the inner side was perfectly upright, and the rubble near the upright part was quite white instead of yellow, showing that the excavators, when they came to the shafts, had cut through the rubble which had been used previously to fill up the shaft; the excavation was then continued into the shaft to 6 feet 6 inches below the old bottom of the ditch, and deer-horn tines and the scapula of an ox were found. In the bottom of the shaft galleries were found opening out of it; one ran north for twenty feet, and was two feet high. It rose at an angle of 5°, which was the angle of stratification of the chalk. In the sides of the galleries, at a height of a foot and a half, here and there, flints were found *in situ*, so that it was plain that the seam of flints had been followed. The flints were not reached till they got to seventeen feet below the original surface of the ground. Another gallery was found running south, and then a chamber was entered, which became high, and it was discovered that it communicated with a shaft in the counterscarp of the ditch. It was conclusively proved that the shaft had been filled in before the ditch was made, and that afterwards the rubble which filled in the inner shaft had been thrown up over the outer shaft forming the rampart. The shaft had been filled in up to the top, apparently by the people who had made it. In filling it they had partly used rubble and partly clay. It was found in layers sloping down, intersected with seams of clay; these seams were quite unconformable with the shaft or with the surrounding strata, but they were evidently derived from clay which was to be met with near the surface of the upper part of the entrenchment. They then followed out another shaft, and when nearly at the bottom he was astounded by a human jaw-bone falling down at his feet from the wall of the shaft; and looking up, he saw the skull resting with the base downwards between two of the blocks of chalk rubble. He procured at once other eyes to see it in its actual position, and then it was taken away, for it was in a very precarious situation. It and the accompanying human bones would be commented on by Prof. Rolleston. This and another shaft gave the same evidences, and had galleries running out of them, and it was clear that the outer rampart had been formed by the rubble thrown out from these filled-up shafts. A seam of flints was found in one of the galleries, and around and on the surfaces of some of them were found a number of marks which corresponded exactly with the deer-horn tines found, so that evidently the flints had been picked out by the aid of deer-horns. As to the implement found, in his opinion there were all transitions between Palæolithic and Neolithic implements. But the resemblance to palæolithic might be, he thought, more apparent than real, and partly might be due to their being unfinished. It was very difficult to command the breaking of flints, as he had found by actual experiment; and thus many unfinished implements were left in the pits. But there was one celt which was finished at the thin end, and was evidently of the Palæolithic type; and others were plainly roughened at the broad end so as to be held in the hand. He thought at any rate that these flints were of a very early Neolithic period, and showed considerable traces of the Palæolithic, though there might yet remain a gap between the periods. The shafts had been kept open, and would still be open for another fortnight, when, by agreement with the owner, they were to be closed up. Many of the leading authorities in this department had visited the place, but subsequently the only actual plan of the workings would be the wooden model which he exhibited, showing all the strata, shafts, and galleries.

Prof. Rolleston then proceeded to speak of the animal remains. He said the snail and other shells found were of great use, and supplied a cogent argument, without ambiguity, as cogent as Euclid. Here was the sharp line of the shaft, and at a depth of fourteen feet from the original surface were found an immense number of *Cyclostoma elegans*, *Helix nemoralis*, and other hybernating snail shells. They were not brought down to be eaten by the excavators, as was supposed, but the opercula were still found exactly *in situ*, giving evidence that they had gone down for warmth and shelter while still alive. They had also found plenty of food in the moist conditions of the shaft. They had undoubtedly gone down the shaft at a time when it was still open; and further evidence was that no snail shells at all were to be found in the rubble which had gradually dribbled down. He thought that the abundance of the shells was to be explained by the fact that these prehistoric Britons, like our own countrymen of the present day, were a little negligent in putting an end to nuisances, whether they were open shafts or otherwise, and thus the shaft had been open a good while, and a large series of snails had lived here. And among other results of this negligence was, he believed, the fall of a young British lady into the shaft. At any rate her bones had been found in a position quite compatible with this idea. With the skeleton were found a large number of pig-bones; there were at least four individuals, one old and three younger. We have not the entire skeleton of any one of them, and it was quite compatible with the evidence that these bones might have been thrown in piecemeal. Other bones were found, all of domestic animals, especially a small animal which might be a sheep or a goat; the critical pieces of the skeleton were absent. As to the *Bos primigenius* there was not the smallest doubt, and it was found in a position which showed it to have occurred before the advent of the small domestic animals; and wild animals of the same kinds must have then been much larger, or they would speedily have been exterminated by the wolves. As to the female skeleton, nearly all the bones were preserved, scarcely three of the vertebræ being missing. She was evidently between eighteen and twenty-five years of age, by various indications of the bones. She had a large head, yet it was an early type of skull, older than that of the people who built the rampart. The lower jaw contained a large number of teeth. The wisdom teeth were just through, and were scarcely worn at all; yet the two molar teeth in front of them on each side, above and below, were ground down nearly to the stumps. From this he inferred that the food had been of such a character as to produce wearing of the teeth. The evidence of the bones was conclusive as to her youth. The only parallel he could find to this was in the Indians of Vancouver's Island, who fed on fish dried in the sand-blowing winds, and their teeth were thus worn down to the stumps. Similarly these people might have fed on food dried in the wind, in which a large amount of fine sand got embedded. The cubical capacity of the cranium was very large; as measured by rape-seed it was 105·75 cubic inches; and the largest cubical capacity he knew of was one of a great Roman officer out of their burial grounds, whose capacity was 108 cubic inches. The people who made the shafts were undoubtedly older than the Britons who made the great rampart, and *they* were still in a stone-using period.

Mr. John Evans, in the discussion which followed, said that the main difference between Palæolithic and Neolithic was not that in one the implements were merely chipped and in the other polished, but in the manner of occurrence in the strata and the animals associated with them. In the Neolithic he estimated that ninety-five per cent. of all that was found was unpolished—all the smaller tools, &c. He acknowledged that he was not justified in saying that the pointed end of some of the implements from Cissbury was not intended to be used; and there were some cases in which it was impossible to tell which end was to be used. Even granting this exceptional resemblance, there is a great Neolithic facies in the things found at Cissbury. Still, he was quite willing now to accept the particular implement found at Cissbury as a new type of implement to be held in the hand; it might have been used in digging up roots.

SECTION E

GEOGRAPHY.

ADDRESS BY LIEUT.-GENERAL R. STRACHEY, R.E., C.S.I., F.R.S., PRESIDENT.

In accordance with the practice followed for some years past by the Presidents of the Sections of the British Association, I propose, before proceeding with our ordinary business, to offer for your consideration some observations relative to the branch of knowledge with which this Section is more specially concerned.

My predecessors in this chair have, in their opening addresses, viewed geography in many various lights. Some have drawn attention to recent geographical discoveries of interest, or to the gradual progress of geographical knowledge over the earth generally, or in particular regions. Others have spoken of the value of geographical knowledge in the ordinary affairs of men, or in some of the special branches of those affairs, and of the means of extending such knowledge. Other addresses again have dwelt on the practical influence produced by the geographical features and conditions of the various parts of the earth on the past history and present state of the several sections of the human race, the formation of kingdoms, the growth of industry and commerce, and the spread of civilisation.

The judicious character of that part of our organisation which leads to yearly changes among those who preside over our meetings, and does not attempt authoritatively to prescribe the direction of our discussions, will no doubt be generally recognised. It has the obvious advantage, amongst others, of ensuring that none of the multifarious claims to attention of the several branches of science shall be made unduly prominent, and of giving opportunity for viewing the subjects which from time to time come before the Association in fresh aspects by various minds.

Following, then, a somewhat different path from those who have gone before me in treating of Geography, I propose to speak of the physical causes which have impressed on our planet the present outlines and forms of its surface, have brought about its present conditions of climate, and have led to the development and distribution of the living beings found upon it.

In selecting this subject for my opening remarks, I have been not a little influenced by a consideration of the present state of geographical knowledge, and of the probable future of geographical investigation. It is plain that the field for mere topographical exploration is already greatly limited, and that it is continually becoming more restricted. Although no doubt much remains to be done in obtaining detailed maps of large tracts of the earth's surface, yet there is but comparatively a very small area with the essential features of which we are not now fairly well acquainted. Day by day our maps become more complete, and with our greatly improved means of communication the knowledge of distant countries is constantly enlarged and more widely diffused. Somewhat in the same proportion the demands for more exact information become more pressing. The necessary consequence is an increased tendency to give to geographical investigations a more strictly scientific direction. In proof of this I may instance the fact that the two British naval expeditions now being carried on, that of the *Challenger* and that of the Arctic seas, have been organised almost entirely for general scientific research, and comparatively little for topographical discovery. Narratives of travels, which not many years ago might have been accepted as valuable contributions to our then less perfect knowledge, would now perhaps be regarded as superficial and insufficient. In short, the standard of knowledge of travellers and writers on geography must be raised to meet the increased requirements of the time.

Other influences are at work tending to the same result. The great advance made in all branches of natural science limits more and more closely the facilities for original research, and draws the observer of nature into more and more special studies, while it renders the acquisition by any individual of the highest standard of knowledge in more than one or two special subjects comparatively difficult and rare. At the same time the mutual inter-dependence of all natural phenomena daily becomes more apparent; and it is of ever-increasing importance that there shall be some among the cultivators of natural knowledge who specially direct their attention to the general relations existing among all the forces and phenomena of nature. In some important branches of such subjects, it is only through study of the local physical conditions of various parts of the earth's surface and the complicated phenomena to which they give rise, that sound conclusions can be established; and this study constitutes physical or scientific geography. It is very necessary to bear in mind that a large portion of the phenomena dealt with by the sciences of observation relates to the earth as a whole in contradistinction to the substances of which it is formed, and can only be correctly appreciated in connection with the terrestrial or geographical conditions of the place where they occur. On the one hand, therefore, while the proper prosecution of the study of physical geography requires a sound knowledge of the researches and conclusions of students in the special branches of science, on the other success is not attainable in the special branches without suitable apprehension of geographical facts. For these reasons it appears to me that the general progress of science will involve the study of geography in a more scientific spirit, and with a clearer conception of its true function, which is that of obtaining accurate notions of the manner in which the forces of nature have brought about the varied conditions characterising the surface of the planet which we inhabit.

In its broadest sense science is organised knowledge, and its methods consist of the observation and classification of the phenomena of which we become conscious through our senses, and the investigation of the causes of which these are the effects. The first step in geography, as in all other sciences, is the observation and description of the phenomena with which it is concerned; the next is to classify and compare this empirical collection of facts, and to investigate their antecedent causes. It is in the first branch of the study that most progress has been made, and to it indeed the notion of geography is still popularly limited. The other branch is commonly spoken of as physical geography, but it is more correctly the science of geography.

The progress of geography has thus advanced from first rough ideas of relative distance between neighbouring places, to correct views of the earth's form, precise determinations of position, and accurate delineations of the surface. The first impressions of the differences observed between distant countries were at length corrected by the perception of similarities no less real. The characteristics of the great regions of polar cold and equatorial heat, of the sea and land, of the mountains and plains, were appreciated; and the local variations of season and climate, of wind and rain, were more or less fully ascertained. Later, the distribution of plants and animals, their occurrence in groups of peculiar structure in various regions, and the circumstances under which such groups vary from place to place, gave rise to fresh conceptions. Along with these facts were observed the peculiarities of the races of men—their physical form, languages, customs, and history—exhibiting on the one hand striking differences in different countries, but on the other often connected by a strong stamp of similarity over large areas.

By the gradual accumulation and classification of such knowledge the scientific conception of geographical unity and continuity was at length formed, and the conclusion established that while each different part of the earth's surface has its special characteristics, all animate and inanimate nature constitutes one general system, and that the particular features of each region are due to the operation of universal laws acting under varying local conditions. It is upon such a conception that is now brought to bear the doctrine, very generally accepted by the naturalists of our own country, that each successive phase of the earth's history, for an indefinite period of time, has been derived from that which preceded it, under the operation of the forces of nature as we now find them; and that, so far as observation justifies the adoption of any conclusions on such subjects, no change has ever taken place in those forces, or in the properties of matter. This doctrine is commonly spoken of as the doctrine of evolution, and it is to its application to geography that I wish to direct your attention.

I desire here to remark that in what I am about to say, I altogether leave on one side all questions relating to the origin of matter, and of the so-called forces of nature which give rise to the properties of matter. In the present state of knowledge such subjects are, I conceive, beyond the legitimate field of physical science, which is limited to discussions directly arising on facts within the reach of observation, or on reasonings based on such facts. It is a necessary condition of the progress of knowledge that the line between what properly is or is not within the reach of human intelligence is ill defined, and that opinions will vary as to where it should be drawn; for it is the avowed and successful aim of science to keep this line constantly shifting by pushing it forward; many of the efforts made to do this are no doubt founded in error, but all are deserving of respect that are undertaken honestly.

The conception of evolution is essentially that of a passage to the state of things which observation shows us to exist now, from some preceding state of things. Applied to geography, that is to say to the present condition of the earth as a whole, it leads up to the conclusion that the existing outlines of sea and land have been caused by modifications of pre-existing oceans and continents, brought about by the operation of forces which are still in action, and which have acted from the most remote past of which we can conceive; that all the successive forms of the surface—the depressions occupied by the waters, and the elevations constituting mountain-chains—are due to these same forces; that these have been set up, first, by the secular loss of heat which accompanied the original cooling of the globe; and second, by the annual or daily gain and loss of heat received from the sun acting on the matter of which the earth and its atmosphere are composed; that all variations of climate are dependent on differences in the condition of the surface; that the distribution of life on the earth, and the vast varieties of its forms, are consequences of contemporaneous or antecedent changes of the forms of the surface and climate; and thus that our planet as we now find it is the result of modifications gradually brought about in its successive stages, by the necessary action of the matter out of which it has been formed, under the influence of the matter which is external to it.

I shall state briefly the grounds on which these conclusions are based.

So far as concerns the inorganic fabric of the earth, that view of its past history which is based on the principle of the persistence of all the forces of nature may be said to be now universally adopted. This teaches that the almost infinite variety of natural phenomena arises from new combinations of old forms of matter, under the action of new combinations of old forms of force. Its recognition has, however, been comparatively recent, and is in a great measure due to the teachings of that eminent geologist, the late Sir Charles Lyell, whom we have lost during the past year.

When we look back by the help of geological science to the more remote past, through the epochs immediately preceding our own, we find evidence of marine animals—which lived, were reproduced, and died,—possessed of organs proving that they were under the influence of the heat and light of the sun; of seas whose waves rose before the winds, breaking down cliffs, and forming beaches of boulders and pebbles; of tides and currents spreading out banks of sand and mud, on which are left the impress of the ripple of the water, of drops of rain, and of the track of animals; and all these appearances are precisely similar to those we observe at the present day as the result of forces which we see actually in operation. Every successive stage, as we recede in the past history of the earth, teaches the same lesson. The forces which are now at work, whether in degrading the surface by the action of seas, rivers, or frosts, and in transporting its fragments into the sea, or in reconstituting the land by raising beds laid out in the depth of the ocean, are traced by similar effects as having continued in action from the earliest times.

Thus pushing back our inquiries we at last reach the point where the apparent cessation of terrestrial conditions such as now exist requires us to consider the relation in which our planet stands to other bodies in celestial space; and vast though the gulf be that separates us from these, science has been able to bridge it. By means of spectroscopic analysis it has been established that the constituent elements of the sun and other heavenly bodies are substantially the same as those of the earth. The examination of the meteorites which have fallen on the earth from the interplanetary spaces, shows that they also contain nothing foreign to the constituents of the earth. The inference seems legitimate, corroborated as it is by the manifest physical connection between the sun and the planetary bodies circulating around it, that the whole solar system is formed of the same descriptions of matter, and subject to the same general physical laws. These conclusions further support the supposition that the earth and other planets have been formed by the aggregation of matter once diffused in space around the sun; that the first consequence of this aggregation was to develop intense heat in the consolidating masses; that the heat thus generated in the terrestrial sphere was subsequently lost by radiation; and that the surface cooled and became a solid crust, leaving a central nucleus of much higher temperature within. The earth's surface appears now to have reached a temperature which is virtually fixed, and on which the gain of heat from the sun is, on the whole, just compensated by the loss by radiation into surrounding space.

Such a conception of the earliest stage of the earth's existence is commonly accepted, as in accordance with observed facts. It leads to the conclusion that the hollows on the surface of the globe occupied by the ocean, and the great areas of dry land, were original irregularities of form caused by unequal contraction; and that the mountains were corrugations, often accompanied by ruptures, caused by the strains developed in the external crust by the force of central attraction exerted during cooling, and were not due to forces directly acting upwards generated in the interior by gases or otherwise. It has recently been very ably argued by Mr. Mallet that the phenomena of volcanic heat are likewise consequences of extreme pressures in the external crust, set up in a similar manner, and are not derived from the central heated nucleus.

There may be some difficulty in conceiving how forces can have been thus developed sufficient to have produced the gigantic changes which have occurred in the distribution of land and water over immense areas, and in the elevation of the bottoms of former seas so that they now form the summits of the highest mountains, and to have effected such changes within the very latest geological epoch. These difficulties in great measure arise from not employing correct standards of space and time in relation to the phenomena. Vast though the greatest heights of our mountains and depths of our seas may be, and enormous though the masses which have been put into motion, when viewed according to a human standard, they are insignificant in relation to the globe as a whole. Such heights and depths (about six miles) on a sphere of ten feet in diameter would be represented on a true scale by elevations and depressions of less than the tenth part of an inch, and the average elevation of the whole of the dry land (about 1,000 feet) above the mean level of the surface would hardly amount to the thickness of an ordinary sheet of paper. The forces developed by the changes of the temperature of the earth as a whole must be proportionate to its dimensions; and the results of their action on the surface in causing elevations, contortions, or disruptions of the strata, cannot be commensurable with those produced by forces having the intensities, or by strains in bodies of the dimensions, with which our ordinary experience is conversant.

The difficulty in respect to the vast extent of past time is perhaps less great, the conception being one with which most persons are now more or less familiar. But I would remind you, that great though the changes in human affairs have been since the most remote epochs of which we have records in monuments or history, there is nothing to indicate that within this period has occurred any appreciable modification of the main outlines of land and sea, or of the condition of climate, or of the general characters of living creatures; and that the distance that separates us from those days is as nothing when compared with the remoteness of past geological ages. No useful approach has yet been made to a numerical estimate of the duration even of that portion of geological time which is nearest to us; and we can say little more than that the earth's past history extends over hundreds of thousands or millions of years.

The solid nucleus of the earth with its atmosphere, as we now find them, may thus be regarded as exhibiting the residual phenomena which have resulted on its attaining a condition of practical equilibrium, the more active process of aggregation having ceased, and the combination of its elements into the various solid, liquid, or gaseous matters found on or near the surface having been completed. During its passage to its present state many wonderful changes must have taken place, including the condensation of the ocean, which must have long continued in a state of ebullition, or bordering on it, surrounded by an atmosphere densely charged with watery vapour. Apart from the movements in its solid crust caused by the general cooling and contraction of the earth, the higher temperature due to its earlier condition hardly enters directly into any of the considerations that arise in connection with its present climate, or with the changes during past time which are of most interest to us; for the conditions of climate and temperature at present, as well as in the period during which the existence of life is indicated by the presence of fossil remains, and which have affected the production and distribution of organised beings, are dependent on other causes, to a consideration of which I now proceed.

The natural phenomena relating to the atmosphere are often extremely complicated and difficult of explanation; and meteorology is the least advanced of the branches of physical science. But sufficient is known to indicate, without possible doubt, that the primary causes of the great series of phenomena, included under the general term climate, are the action and reaction of the mechanical and chemical forces set in operation by the sun's heat, varied from time to time and from place to place, by the influence of the position of the earth in its orbit, of its revolution on its axis, of geographical position, elevation above the sea-level, and condition of the surface, and by the great mobility of the atmosphere and the ocean.

The intimate connection between climate and local geographical conditions is everywhere apparent; nothing is more striking than the great differences between neighbouring places where the effective local conditions are not alike, which often far surpass the contrasts attending the widest separation possible on the globe. Three or four miles of vertical height produce effects almost equal to those of transfer from the equator to the poles. The distribution of the great seas and continents give rise to periodical winds—the trades and monsoons—which maintain their general characteristics over wide areas, but present almost infinite local modifications, whether of season, direction, or force. The direction of the coasts and their greater or less continuity greatly influence the flow of the currents of the ocean; and these, with the periodical winds, tend on the one hand to equalise the temperature of the whole surface of the earth, and on the other to cause surprising variations within a limited area. Ranges of mountains, and their position in relation to the periodical or rain-bearing winds, are of primary importance in controlling the movements of the lower strata of the atmosphere, in which, owing to the laws of elastic gases, the great mass of the air and watery vapour are concentrated. By their presence they may either constitute a barrier across which no rain can pass, or determine the fall of torrents of rain around them. Their absence or their unfavourable position, by removing the causes of condensation, may lead to the neighbouring tracts becoming rainless deserts.

The difficulties that arise in accounting for the phenomena of climate on the earth as it now is, are naturally increased when the attempt is made to explain what is shown by geological evidence to have happened in past ages. The disposition has not been wanting to get over these last difficulties by invoking supposed changes in the sources of terrestrial heat, or in the conditions under which heat has been received by the earth, for which there is no justification in fact, in a manner similar to that in which violent departures from the observed course of nature have been assumed to account for some of the analogous mechanical difficulties.

Among the most perplexing of such climatal problems are those involved in the former extension of glacial action of various sorts over areas which could hardly have been subject to it under existing terrestrial and solar conditions; and in the discovery, conversely, of indications of far higher temperatures at certain places than seems compatible with their high latitudes; and in the alternations of such extreme conditions. The true solution of these questions has apparently been found in the recognition of the disturbing effects of the varying eccentricity of the earth's orbit, which, though inappreciable in the comparatively few years to which the affairs of men are limited, become of great importance in the vastly increased period brought into consideration when dealing with the history of the earth. The changes of eccentricity of the orbit are not of a nature to cause appreciable differences in the mean temperature either of the earth generally or of the two hemispheres; but they may, when combined with changes of the direction of the earth's axis caused by the precession of the equinoxes and nutation, lead to exaggeration of the extremes of heat and cold, or to their diminution; and this would appear to supply the means of explaining the observed facts, though doubtless the detailed application of the conception will long continue to give rise to discussions. Mr. Croll, in his book entitled "Climate and Time," has recently brought together with much research all that can now be said on this subject; and the general correctness of that part of his conclusions which refers to the periodical occurrence of epochs of greatly increased winter cold and summer heat in one hemisphere, combined with a more equable climate in the other, appears to me to be fully established.

These are the considerations which are held to prove that the inorganic structure of the globe through all its successive stages —the earth beneath our feet, with its varied surface of land and sea, mountain and plain, and with its atmosphere which distributes heat and moisture over that surface—has been evolved as the necessary result of the original aggregation of matter at some extremely remote period, and of the subsequent modification of that matter in condition and form under the exclusive operation of invariable physical forces.

From these investigations we carry on the inquiry to the living creatures found upon the earth; what are their relations one to another, and what to the inorganic world with which they are associated?

This inquiry first directed to the present time, and thence carried backwards as far as possible into the past, proves that there is one general system of life, vegetable and animal, which is coextensive with the earth as it now is, and as it has been in all the successive stages of which we obtain a knowledge by geological research. The phenomena of life, as thus ascertained, are included in the organisation of living creatures, and their distribution in time and place. The common bond that subsists between all vegetables and animals is testified by the identity of the ultimate elements of which they are composed. These elements are carbon, oxygen, hydrogen, and nitrogen, with a few others in comparatively small quantities; the whole of the materials of all living things being found among those that compose the inorganic portion of the earth.

The close relation existing between the least specialised animals and plants, and between these and organic matter not having life, and even with inorganic matter, is indicated by the difficulty that arises in determining the nature of the distinctions between them. Among the more highly developed members of the two great branches of living creatures, the well-known similarities of structure observed in the various groups indicate a connection between proximate forms which was long seen to be akin to that derived through descent from a common ancestor by ordinary generation.

The facts of distribution show that certain forms are associated in certain areas, and that as we pass from one such area to another the forms of life change also. The general assemblages of living creatures in neighbouring countries easily accessible to one another, and having similar climates, resemble one another; and much in the same way, as the distance between areas increases, or their mutual accessibility diminishes, or the conditions of climate differ, the likeness of the forms within them becomes continually less apparent. The plants and animals existing at any time in any locality tend constantly to diffuse themselves around that local centre, this tendency being controlled by the conditions of climate, &c., of the surrounding area, so that under certain unfavourable conditions diffusion ceases.

The possibilities of life are further seen to be everywhere directly influenced by all external conditions, such as those of climate, including temperature, humidity, and wind; of the length of the seasons and days and nights; of the character of the surface, whether it be land or water, and whether it be covered by vegetation or otherwise; of the nature of the soil; of the presence of other living creatures, and many more. The abundance of forms of life in different areas (as distinguished from number of individuals) is also found to vary greatly, and to be related to the accessibility of such areas to immigration from without; to the existence, within or near the areas, of localities offering considerable variations of the conditions that chiefly affect life; and to the local climate and conditions being compatible with such immigration.

For the explanation of these and other phenomena of organisation and distribution, the only direct evidence that observation can supply is that derived from the mode of propagation of creatures now living; and no other mode is known than that which takes place by ordinary generation, through descent from parent to offspring.

It was left for the genius of Darwin to point out how the course of nature, as it now acts in the reproduction of living creatures, is sufficient for the interpretation of what had previously been incomprehensible in these matters. He showed how propagation by descent operates subject to the occurrence of certain small variations in the offspring, and that the preservation of some of these varieties to the exclusion of others follows as a necessary consequence when the external conditions are more suitable to the preserved forms than to those lost. The operation of these causes he called Natural Selection. Prolonged over a great extent of time, it supplies the long-sought key to the complex system of forms either now living on the earth, or the remains of which are found in the fossil state, and explains the relations among them, and the manner in which their distribution has taken place in time and space.

Thus we are brought to the conclusion that the directing forces which have been efficient in developing the existing forms of life from those which went before them, are those same successive external conditions including both the forms of land and sea, and the character of the climate, which have already been shown to arise from the gradual modification of the material fabric of the globe as it slowly attained to its present state. In each succeeding epoch, and in each separate locality, the forms preserved and handed on to the future were determined by the general conditions of surface at the time and place; and the aggregate of successive sets of conditions over the whole earth's surface has determined the entire series of forms which have existed in the past, and have survived till now.

As we recede from the present into the past, it necessarily follows, as a consequence of the ultimate failure of all evidence as to the conditions of the past, that positive testimony of the conformity of the facts with the principle of evolution gradually diminishes, and at length ceases. In the same way positive evidence of the continuity of action of all the physical forces of nature eventually fails. But inasmuch as the evidence, so far as it can be procured, supports the belief in this continuity of action, and as we have no experience of the contrary being possible, the only justifiable conclusion is, that the production of life must have been going on as we now know it, without any intermission, from the time of its first appearance on the earth.

These considerations manifestly afford no sort of clue to the origin of life. They only serve to take us back to a very remote epoch, when the living creatures differed greatly in detail from those of the present time, but had such resemblances to them as to justify the conclusion that the essence of life then was the same as now; and through that epoch into an unknown anterior period, during which the possibility of life, as we understand it, began, and from which has emerged in a way that we cannot comprehend, matter with its properties, bound together by what we call the elementary physical forces. There seems to be no foundation in any observed fact for suggesting that the wonderful property which we call life appertains to the combinations of elementary substances in association with which it is exclusively found, otherwise than as all other properties appertain to the particular forms or combinations of matter with which they are associated. It is no more possible to say how originated or operates the tendency of some sorts of matter to take the form of vapours, or fluids, or solid bodies, in all their various shapes, or for the various sorts of matter to attract one another or combine, than it is to explain the origin in certain forms of matter of the property we call life, or the mode of its action. For the present, at least, we must be content to accept such facts as the foundation of positive knowledge, and from them to rise to the apprehension of the means by which nature has reached its present state, and is advancing into an unknown future.

These conceptions of the relations of animal and vegetable forms to the earth in its successive stages lead to views of the significance of type (*i.e.* the general system of structure running through various groups of organised beings) very different from those under which it was held to be an indication of some occult power directing the successive appearance of living creatures on the earth. In the light of evolution, type is nothing more than the direction given to the actual development of life by the surface conditions of the earth, which have supplied the forces that controlled the course of the successive generations leading from the past to the present. There is no indication of any adherent or pre-arranged disposition towards the development of life in any particular direction. It would rather appear that the actual face of nature is the result of a succession of apparently trivial incidents, which by some very slight alteration of local circumstances might often, it would seem, have been turned in a different direction. Some otherwise unimportant difference in the constitution or sequence of the substrata at any locality might have determined the elevation of mountains where a hollow filled by the sea was actually formed, and thereby the whole of the climatal and other conditions of a large area would have been changed, and an entirely different impulse given to the development of life locally, which might have impressed a new character on the whole face of nature.

But further, all that we see or know to have existed upon the earth has been controlled to its most minute details by the original constitution of the matter which was drawn together to form our planet. The actual character of all inorganic substances, as of all living creatures, is only consistent with the actual constitution and proportions of the various substances of which the earth is composed. Other proportions than the actual ones in the constituents of the atmosphere would have required an entirely different organisation in all air-breathing animals, and probably in all plants. With any considerable difference in the quantity of water either in the sea or distributed as vapour, vast changes in the constitution of living creatures must have been involved. Without oxygen, hydrogen, nitrogen, or carbon, what we term life would have been impossible. But such speculations need not be extended.

The substances of which the earth is now composed are identical with those of which it has always been made up; so far as is known it has lost nothing and has gained nothing, except what has been added in extremely minute quantities by the fall of meteorites. All that is or ever has been upon the earth is part of the earth, has sprung from the earth, is sustained by the earth, and returns to the earth; taking back thither what it withdrew, making good the materials on which life depends, without which it would cease, and which are destined again to enter into new forms, and contribute to the ever onward flow of the great current of existence.

The progress of knowledge has removed all doubt as to the relation in which the human race stands to this great stream of life. It is now established that man existed on the earth at a period vastly anterior to any of which we have records in history or otherwise. He was the contemporary of many extinct mammalia at a time when the outlines of land and sea, and the conditions of climate over large parts of the earth, were wholly different from what they now are, and our race has been advancing towards its present condition during a series of ages for the extent of which ordinary conceptions of time afford no suitable measure. These facts have, in recent years, given a different direction to opinion as to the manner in which the great groups of mankind have become distributed over the areas where they are now found; and difficulties once considered insuperable become soluble when regarded in connection with those great alterations of the outlines of land and sea which are shown to have been going on up to the very latest geological periods. The ancient monuments of Egypt, which take us back perhaps 7,000 years from the present time, indicate that when they were erected the neighbouring countries were in a condition of civilisation not very greatly different from that which existed when they fell under the dominion of the Romans or Mahometans hardly 1,500 years ago; and the progress of the population towards that condition can hardly be accounted for otherwise than by prolonged gradual transformations going back to times so far distant as to require a geological rather than an historical standard of reckoning.

Man, in short, takes his place with the rest of the animate world, in the advancing front of which he occupies so conspicuous a position. Yet for this position he is indebted not to any exclusive powers of his own, but to the wonderful compelling forces of nature which have lifted him entirely without his knowledge, and almost without his participation, so far above the animals of whom he is still one, though the only one able to see or consider what he is.

For the social habits essential to his progress, which he possessed even in his most primitive state, man is without question dependent on his ancestors, as he is for his form and other physical peculiarities. In his advance to civilisation he was insensibly forced, by the pressure of external circumstances, through the more savage condition, in which his life was that of the hunter, first to pastoral and then to agricultural occupations. The requirements of a population gradually increasing in numbers could only be met by a supply of food more regular and more abundant than could be provided by the chase. But the possibility of the change from the hunter to the shepherd or herdsman rested on the antecedent existence of animals suited to supply man with food, having gregarious habits, and fitted for domestication, such as sheep, goats, and horned cattle; for their support the social grasses were a necessary preliminary, and for the growth of these in sufficient abundance land naturally suitable for pasture was required. A further evasion of man's growing difficulty in obtaining sufficient food was secured by aid of the cereal grasses, which supplied the means by which agriculture, the outcome of pastoral life, became the chief occupation of more civilised generations. Lastly, when these increased facilities for providing food were in turn overtaken by the growth of the population, new power to cope with the recurring difficulty was gained through the cultivation of mechanical arts and of thought, for which the needful leisure was for the first time obtained when the earliest steps of civilisation had removed the necessity for unremitting search after the means of supporting existence. Then was broken down the chief barrier in the way of progress, and man was carried forward to the condition in which he now is.

It is impossible not to recognise that the growth of civilisation, by aid of its instruments, pastoral and agricultural industry, was the result of the unconscious adoption of defences supplied by what was exterior to man, rather than of any truly intelligent steps taken with forethought to attain it; and in these respects man, in his struggle for existence, has not differed from the humbler animals or from plants. Neither can the marvellous ultimate growth of his knowledge, and his acquisition of the power of applying to his use all that lies without him, be viewed as differing in anything but form or degree from the earlier steps in his advance. The needful protection against the foes of his constantly increasing race—the legions of hunger and disease, infinite in number, ever changing their mode of attack or springing up in new shapes—could only be attained by some fresh adaptation of his organisation to his wants, and this has taken the form of that development of intellect which has placed all other creatures at his feet and all the powers of nature in his hand.

The picture that I have thus attempted to draw presents to us our earth carrying with it, or receiving from the sun or other external bodies, as it travels through celestial space, all the materials and all the forces by help of which are fashioned whatever we see upon it. We may liken it to a great complex living organism, having an inert substratum of inorganic matter on which are formed many separate organised centres of life, but all bound up together by a common law of existence, each individual part depending on those around it, and on the past condition of the whole. Science is the study of the relations of the several parts of this organism one to another, and of the parts to the whole. It is the task of the geographer to bring together from all places on the earth's surface the materials from which shall be deduced the scientific conception of nature. Geography supplies the rough blocks wherewith to build up that grand structure towards the completion of which science is striving. The traveller, who is the journeyman of science, collects from all quarters of the earth observations of fact, to be submitted to the research of the student, and to provide the necessary means of verifying the inductions obtained by study or the hypotheses suggested by it. If therefore travellers are to fulfil the duties put upon them by the division of scientific labour, they must maintain their knowledge of the several branches of science at such a standard as will enable them thoroughly to apprehend what are the present requirements of science, and the classes of fact on which fresh observation must be brought to bear to secure its advance. Nor does this involve any impracticable course of study. Such knowledge as will fit a traveller for usefully participating in the progress of science is now placed within the reach of everyone. The lustre of that energy and self-devotion which characterise the better class of explorers will not be dimmed by joining to it an amount of scientific training which will enable them to bring away from distant regions enlarged conceptions of other matters besides mere distance and direction. How great is the value to science of the observations of travellers endowed with a share of scientific instruction is testified by the labours of many living naturalists. In our days this is especially true; and I appeal to all who desire to promote the progress of geographical science as explorers, to prepare themselves for doing so efficiently, while they yet possess the vigour and physical powers that so much conduce to success in such pursuits.

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THERE seems to have been few papers of striking importance read at the Nantes meeting of this Association, though the large number and the solid character of most of the papers show that the scientific activity of France continues to be well sustained. The following are some of the principal papers read in the various sections:—

Zoology.—M. Bureau presented some very interesting observations on the *Aquila pennata*, Brehm and Briss, which he has had the opportunity of closely observing. He is convinced that all the varieties belong to two types, which he has named the white and the black types. Pairs belong sometimes to one type, very often to two different types; generally the young are completely black or completely white.

M. Giard gave an account of his researches on some controverted points in the embryogeny of the Ascidians, more especially *Molgula socialis*, which he has studied in the zoological laboratory of Wimereux. He has been able to supplement and correct in several respects the conclusions of previous observers. M. Giard also, after long research into the embryogeny of animals belonging to the various classes into which Cuvier divided the *Articulata* and *Mollusca*, proposed another limitation of these two groups. Another paper by the same was concerned with the embryogeny of the pectinibranchiate *Gasteropoda*.

Prof. Sirodot described in detail the results of his researches on Elephants. M. Sirodot remarked that, having had at his disposal a very large number of teeth, he had been able not only to correct the errors committed by Falconnet and De Blainville, but, moreover, to feel confident that the different species of *Elephas* hitherto described as closely allied to the Mammoth have no value whatever. There are a multitude of intermediate forms connecting the *Elephas primigenius* with *Elephas indicus*.

M. Lortet, while in Syria, made some investigations into the organisation and reproduction of fibrous sponges. He has been able to prove the presence and to follow the formation of the male and the female egg. Apart from these genital products, he did not meet, in the sponges which he examined, any other cellular element. M. Lortet did not observe, moreover, any canals running into the great canal of the ovule, canals referred to by a large number of zoologists. M. Lortet also described his observations on the very peculiar fauna of the Lake of Tiberias. This fauna appears to indicate a former communication between the waters of the lake and those of the sea.

Physics.—M. Cornu indicated a very simple process for determining with accuracy the focal distance and the principal points of lenses.

M. Merget explained the very interesting results of his researches on the thermo-diffusion of porous and humid pulverulent bodies. A thermo-diffuser is generally a porous vessel, filled with an inert powder, in the middle of which is a glass tube or a metallic tube riddled with holes. On heating such an apparatus, after having moistened it, steam is disengaged in abundance through the porous substance, while dry air traverses the apparatus in an inverse direction, and escapes by the tube. If this escape be prevented, there is produced a pressure which reached three atmospheres at a dull red heat. If the pulverulent mass or the porous body ceases to be moist, no gas escapes. The author did not explain the fact, but he showed that the explanation of it given by M. De la Rive cannot be accepted. M. Merget is convinced that there is here a thermo-dynamic phenomenon. Thermo-diffusion must play an important part in the gaseous exchanges of vegetable life; the author showed this by taking a leaf of *Nelumbium* as a thermo-diffuser.

M. Gripon communicated to the Section and repeated various experiments which he had performed with films of collodion. In receiving upon a Savart polariscope light polarised by a lamina of collodion, we have there systems of fringes, one normal, the other due to phenomena of secondary interference. By illuminating a film of collodion with the light reflected by a second film, we easily obtain fringes of interference, as in the experiment of Brewster. Collodion films are very diathermanous for luminous heat; they are less so for dark heat.

M. Mascart showed some very curious experiments on the condensation resulting from the expansion of moist air. If a little water is placed in the bottom of a perfectly clean flask, closed by a glass tube terminated by an indiarubber syphon bag, we have a closed space, which soon becomes saturated with moisture. By pressing on the bag the temperature rises, and there can be no condensation. But by allowing the bag to resume, by its elasticity, its original form, the air expands, is consequently cooled, and, contrary to what is usually observed, no condensation takes place. To produce the condensation ordinarily observed, it is sufficient to introduce into the flask some unfiltered air, while filtered air produces no effect. In the same way very beautiful clouds are obtained by introducing a little tobacco smoke, or gases resulting from any kind of combustion. These experiments may be of some use in explaining the formation of clouds.

M. Deprez presented an ingenious electric chronograph, intended to estimate by the graphic method intervals of time extremely small, as the duration of a shock.

M. Cornu explained his experiments on the rate of light, by the method of M. Fizeau. (See NATURE, vol. xi. p. 274).

Dr. Moreau explained some points in his investigations on the swim-bladder of fishes, and showed particularly that in proportion as a fish sinks the effort which it must make diminishes.

M. Dufet read a paper on his researches into the electric conductibility of pyrites.

In the Section of *Geology* and *Mineralogy*, most of the papers referred to local topics. Of those of general interest we mention the following:—M. Henry Dufet described his experiments on the thermic conductibility of certain schistose rocks, from which he drew some interesting conclusions regarding the deformations of the fossils contained in such rocks. M. Charles Vélain read a paper on his exploration of the islands of St. Paul and Amsterdam, while on the expedition for observing the Transit of Venus. M. Lory presented some considerations on the dislocation of rocks in mountainous countries.

Botany.—In this section M. Sirodot gave an account of his researches on the classification and development of *Batrachospermum*, and M. de Lanessan spoke on the floral organogeny of *Zostera*.

M. J. Chatin described the results of his histological and histogenic researches on the interior leaf glands and some analogous productions. After having studied the mode of formation of the structure of these various organs in many families, he draws the following conclusions:—1. The interior leaf glands originate always in the mesophyll. 2. These glands are formed by differentiation from a cellule in which multiplication by division is rapidly produced, so that except in some Lauraceæ the gland is always formed, in its perfect state, from a cellular mass, more or less considerable. 3. The products of secretion are constantly forming in the cellules proper of the gland. 4. The elements of the latter are re-absorbed from the centre to the circumference, and thus form a reservoir where the product of secretion is amassed. 5. In certain plants, and by an analogous phenomenon, there may be formed in the leaf true secreting canals. 6. The leaf-glands are almost constantly situated in the vicinity of the fibro-muscular bundles. 7. In many plants there exist at different points of the stalk, of the branches, and of the petioles, certain productions on the whole comparable to the interior leaf-glands.

M. Merget gave the result of his researches on the interchange of gases between plants and the atmosphere. He concluded with the following statements:—1. The means by which the interchange of gases is effected in plants are the stomata and accidental openings; it is by diffusion in the stomata, and not by dialysis through the cuticle, that exterior gases penetrate into the interior of a plant, and that internal gases escape. 2. The entry of atmospheric gases is due to the action of the physical force produced by the phenomena of gaseous thermo-diffusion. M. Merget concluded by some interesting details on the function of chlorophyll.

M. Baillon read a very interesting communication on the Amentaceæ.

In the Section of *Anthropology*, we note the following papers:—Dr. Lagneau read a careful and elaborate memoir on the ethnogeny of the populations of the N. W. of France, in which he reviewed the various peoples which have contributed to the formation of the former and present population of the region comprised between the sea, the Saône, and the Loire.—M. Chauvet read a report relative to the excavations undertaken by the Archæological Society of Charente, in the tumuli on a woody plateau near a Roman road, and entered into details of a nature to clear up certain controverted points of prehistoric archæology. From the objects found in these explorations, M. Chauvet develops a doctrine according to which there was no gap between the various civilisations from an industrial point of view.

As usual, a very large number of papers belong to the Section of Medical Sciences; some of these are of more than merely technical interest, but our space prevents us from referring to them in detail. A full report of the proceedings will be found in the *Revue Scientifique* for August 28 and following weeks.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—DETROIT MEETING

THE American Association for the Advancement of Science held its twenty-fourth annual meeting at Detroit, Mass., from Aug. 11 to 17 inclusive. Some of its previous meetings have surpassed this one in respect to the number of members present, but none can be regarded as superior to it in the general excellence of the communications presented. The causes of the slight falling off in attendance may be briefly mentioned. The cities of the Atlantic sea-board where local scientific societies have been longest in existence, and where a large proportion of the membership of the Association is resident, are 750 to 1,000 miles, chiefly eastward, from Detroit. That city, on the boundary line between the United States and Canada, is also considerably to the northward of the larger centres of population in the Western States. Thus, then, the assembling at Detroit required, in the great majority of instances, a long, tedious, and rather expensive journey. It need not be concealed that, owing to the widespread effects of the depression in all branches of business in the United States—extending even to the learned professions—the pecuniary means of members were in many cases more restricted than usual; and this fact in many cases decided adversely the question of attendance at the meeting.

A protracted series of discussions in that and previous years resulted at the meeting of 1874 in the Association's adopting a new constitution, which first displayed its general effects at Detroit. The two prominent features of change were modelled upon the system of the British Association. A division was made between Fellows and the rest of the members, prominence or usefulness in science being required for election to the honours of Fellowship. This elective process did not, however, apply to the Fellows who became such between the meetings at Hartford and Detroit, and consequently many have been admitted to the dignity who have no claim to it by scientific labours. To the Fellows rather than to the general membership, the guidance and management of the Association is confided. The effect of this change was very apparent at Detroit in the exclusion of a large number of communications which would easily have passed the ordeal of committees and been read at the meetings of previous years. The chosen remainder reached a higher average of excellence than has been hitherto attained, and in the section of Physics, Mathematics, and Chemistry, the weeding process so reduced the number of communications that the supply gave out before the close of the meeting; but this may also be accounted for by the fact that the sub-section of Chemistry, for the first time organised and separately at work, much facilitated the dispatch of business in Section A. A variety of concurrent causes presented a like result from being reached in Section B, devoted to Geology and Biology. The geologists are always largely in force when the Association meets west of the Alleghanies, the development of the mining resources of the newer States and Territories rendering their labours of immediate economic interest and value. There was an extraordinary accession of ethnological papers, prompted chiefly by numerous discoveries recently made in new and very thorough explorations of Indian mounds. The great injuries which the food crops of the United States have suffered from insects within a year or two, called forth several papers of merit from the leading entomologists, as well as much debate and some action on the part of the Association. Besides all the foregoing subjects, there was an unusual number of papers on specific investigations in natural history. These were largely the fruit of the seed sown at the Anderson School on Penikese Island, by the lamented Agassiz. The pupils there instructed, mostly for the first time, in observing the habits of animals, dissecting their forms and studying their differences, were from all parts of the Union. Nearly all of them are teachers in high schools and the smaller colleges. Having been thus started on the path of original investigation, they already find something new to relate, and their papers had a charm of freshness, very different from those of older members who have found their own easier grooves of thought and lapsed into routine.]

Another important feature introduced at this year's meeting by the new constitution, resulted from the election of two vice-presidents, who were the presiding officers respectively of Sections A and B. Following in this respect the system of the British Association, each of these officers opened his Section with an address, in which a department of science was made the subject of a broad survey. Hitherto the address of the retiring President has been the only one at each meeting of this character; the change gives two such addresses in addition, and may in future years give a greater number. At the Detroit meeting the address of Prof. John L. Le Conte, of Philadelphia, the retiring President, brought forward in a general way the aid to a knowledge of past conditions on the globe, which might be derived from a study of existing forms. Prof. Le Conte's own lines of investigation have been more especially confined to the study of insects, and from the facts thus derived he drew most of his illustrations. He regards organic life as furnishing everywhere evidences of design, and a principal portion of the address was devoted to deprecating the conflict between science and religion, and to urging patience rather than controversy. Prof. H. A. Newton, the astronomer, of Yale College, delivered the opening address of Section A. He urged the study of pure mathematics as a basis for work in all the sciences; adducing, through a wide range of illustration, the evidences of its value in advancing knowledge. The want of a thorough knowledge of the higher mathematics he regarded as a frequent defect among American men of science, while their dependence upon mathematical methods in all branches of investigation was every day becoming more absolute.

The address of Prof. J. W. Dawson, Principal of McGill College, Montreal, before Section B, was one of the most important given at the meeting. He is well known as the most able and prominent anti-Darwinian in America. His address took the form of a discussion of the question, "What do we know of the origin and history of life on our planet?" Space will not permit an analysis of this address, which reviewed the evidence furnished by the Silurian fossils at great length, regarding it as inconclusive when applied to the support of evolution theories. Prof. Dawson vigorously opposed the hypothesis that organic life is a product of mere physical forces.

Thus the weight of utterance in two of the addresses is adverse to Darwinian theories, but this is no index to the general sentiment of the leading students of biology in the Association. The officers chosen for next year include names noted in connection with the advocacy of the most advanced evolutionary doctrines. The venerable President-elect, Prof. Wm. B. Rogers, of Boston, was, in years gone by, the most successful antagonist, in discussions of the new theories, that Prof. Agassiz encountered in America. Prof. Edward S. Morse, Vice-president-elect, of Section B, has attained prominence in the expression of strong Darwinian views before large popular audiences in almost every city of the United States. Prof. Charles A. Young, of Dartmouth College, well known by his spectroscopic researches on the sun's chromosphere, was elected Vice-president to preside over Section A. It is a somewhat remarkable circumstance that six out of eight of the officers for next year are residents of the New England States, the three highest positions falling to their share. The citizens of Detroit did everything in their power to make the visit of the Association pleasant. Several social entertainments and excursions by boat and rail were provided, and the Detroit Scientific Association aided materially in these hospitalities. The next meeting will be held August 23, 1876, at Buffalo.* W. C. W.

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* Next week we shall refer to some of the principal papers in detail.

NOTES

We have received from the Central Meteorological Institute of Sweden the Daily Weather Charts published by the Office for the months of January, February, March, and April last. These charts, constructed from data supplied from nine stations in Sweden, nine in the British Isles, four in Norway, two in Denmark, and four in Russia, including Arkangel, are valuable additions to the daily weather literature of Europe, and supply important data, showing more particularly the influence of the Scandinavian mountains and of the Baltic at different seasons on European storms, and the influence of the systems of high and low pressures over the Baltic and neighbouring regions on the weather of Great Britain at the time.

In the *Bulletin Hebdomadaire* of the Scientific Association of France for September 5, Prof. V. Raulin, after referring in strong, but not too strong, terms to the practical neglect with which the investigation of inundations has been treated in the south-west of France, energetically urges the organising of Hydrometric Commissions similar to that of Lyons, to collect together observations of the rainfall and heights of the rivers, and compare and discuss them with the view of deducing therefrom the laws which rule the commencement, development, and progress down the several river basins, of ordinary floods, but more particularly of those great inundations which prove so disastrous to life and property. He recommends the formation of Hydrometric Commissions at Bordeaux for the basin of the Gironde; at Libourne, for the basin of the Adour; and at Carcassonne or Narbonne, for the basin of the Aude. When the enormous saving to life and property which would have been effected through such organisations, had they existed, is considered, during the late deplorable inundation, we cannot for a moment doubt that Hydrometric Commissions similar to that of Lyons will at once be organised in the basins of the Garonne and its affluents.

The annual Provincial Congress of the Iron and Steel Institute was opened in the Owens College, Manchester, on Tuesday, Mr. William Menelaus, the President of the Institute, in the chair. The Mayors of Manchester and Salford and the Bishop of Manchester were present by invitation, at the opening proceedings, and the more distinguished members of the Institute present included Mr. Henry Bessemer, Sir Joseph Whitworth, Mr. J. Lowthian Bell, and Mr. Crawshay. The Bishop of Manchester gave a very happy address. Referring to the fact that the Duke of Devonshire is an ordinary member of the Institute, one indication among others that the Duke is a man of high scientific attainments in the department of science with which the Institute is connected, the Bishop said that what struck him was how the old order had changed, "giving place to the new," and he was rather inclined to think the new order perhaps somewhat better than the old. The local authorities and the leading industrial firms in Manchester and the surrounding districts have done their part towards rendering the meeting a success. On Tuesday evening the Reception Committee received the members of the Institute at a *conversazione* in the Town Hall, and last evening the members dined at Hulme Town Hall. A large part of the time of the meeting will be spent in visits to places of industrial interest in Manchester and neighbourhood.

The proposed University College for Bristol received some impulse from the members of the British Association at a meeting held last week. Sir John Hawkshaw said foreign industrial competition with England was a very real thing, and would soon be much greater unless scientific education was fostered. Sir W. Thomson begged the promoters not to starve the literary department, and Prof. Balfour Stewart said that would not be any departure from science, for there was now a science of culture and literature. Prof. Jowett said that the appointment of the first professors would be the most critical event in the history of the College, for on their force of character depended the creation of the College out of nothing. Although not more than about 20,000*l*. has been already promised, it is intended to commence operations soon, in the belief that practical successful working will eventually bring in all the funds that are required.

Last Saturday evening the Brothers Henry, the great French asteroid finders, visited the equatorial buildings of the Paris Observatory, under the guidance of M. Leverrier. Along with them was Mr. Watson, the celebrated American astronomer, who has himself discovered no fewer than nineteen small planets. Mr. Watson was the head of the American Transit Expedition to Pekin.

The death of M. de Rémusat renders almost certain the election of M. Dumas to fill the place vacated by the demise of M. Guizot in the French Academy. It is not only that M. Rémusat voted for M. Jules Simon and that the votes were equal, when the election was postponed for six months, but M. Jules Simon has desisted from his candidature, and intends come forward for the seat of his friend Rémusat.

At the Radcliffe Observatory, Oxford, on Sept. 3, 9h. 55m. Greenwich mean time, a meteor was observed about three times the apparent magnitude of Jupiter, proceeding from Saturn downwards about twelve degrees, in the direction of δ Piscis Australis. Colour, blue to green; time visible, five seconds. At disappearance it threw off a piece about the apparent size of Saturn.

The Geological Society of France held a congress at Geneva last week, and visited some of the places most interesting to geologists in that part of Switzerland.

Baron Ferdinand von Mueller, of Melbourne, has just published a second supplement to his previous lists of "Select Plants readily eligible for Victorian Industrial Culture." These lists of Baron Mueller's are useful to a certain extent, many economic plants being thus brought together, arranged alphabetically under their scientific names, and short descriptions given of their uses. Whether many of them are worth the trouble of cultivation as industrial or economic plants, is a question which the cultivator can only know by experience, but which the botanist will be able to decide upon by a mere glance at the list. Thus we find included *Aloe dichotoma*, the Tree Aloe of Damara and Namaqualand, referred to in Nature, vol. xi. p. 89; scarcely an industrial plant, we should say. A peculiar and interesting addition to this second supplement is a geographic index, the plants being alphabetically arranged under distinct heads, such as "Northern and Middle Europe," "Countries at or near the Mediterranean Sea," "Middle and Temperate Eastern Asia," &c.

The coffee plant has been grown in Queensland for some years, but it is only of late that its cultivation has been attempted with a view to its exportation as a commercial article, and we now learn that the plants have become attacked by blight, or fungus, which has given rise to some anxiety and inquiry as to whether the disease is identical with the *Hemileia vastatrix*, which has proved so destructive to coffee plants in Ceylon. We shall probably soon hear more about this, as the subject of the extension of coffee culture in Queensland is about to be taken up by Mr. L. A. Bernays, F.L.S., Clerk of the Legislative Assembly of Queensland, and a vice-president of the Queensland Acclimatisation Society, and who moreover is known as the author of a little work on the cultivation and propagation of the olive in Australia.

The Literary and Natural History Society of Keswick has commenced the formation, in a small room in the Town Hall, of a collection to illustrate the natural history of the district. They have already got together a considerable number of birds, birds' eggs, fishes, and insects, as well as the commencement of a herbarium; also a collection of the rocks and ores and of the scanty fossil fauna of the neighbourhood. A few very interesting celts and other prehistoric remains have been found in the district, some of them close to the celebrated "Druids' Circle" in the immediate vicinity of Keswick. There is evidently here a rich field for the zeal and energy of the local naturalists and archæologists.

THE *Quarterly Journal of the Meteorological Society*, No. 15, has just been published, containing among other matters papers on a Universal System of Meteorography, by Prof. F. Van Rysselberghe; Results of Meteorological Observations at Patras, Greece, during 1873, by the Rev. H. A. Boys; and Notes on Sea Temperature Observations on the British coasts, by R. H. Scott, F.R.S.

A ZOOLOGICAL collection of remarkable interest, the *Times* states, more particularly to Londoners, has been added during the present year to the British Museum. It consists of the Thames Valley series of remains of British elephants, rhinoceri, deer, ox, &c., which have been discovered in the Ilford Marshes, near Stratford, during the last thirty years, and has hitherto formed the unique private collection of Sir Antonio Brady, of Stratford-le-Point. The nature and value of this collection, as now exhibited at the British Museum, will appear from the following facts:—It contains remains of no less than 100 elephants, all of which have been obtained from Ilford. These are referable to two species, viz., *Elephas primigenius*, the mammoth, and *E. antiquus*, a more southern form. The skeletons of each species are represented by many fine examples, and the collection of teeth and jaws represents elephants of every age and size, from the sucking calf, with milk molars, to the patriarch of the herd, whose last molars are so worn that they must have become useless for grinding his food. One characteristic of the Ilford elephants is the number of the plates in the last molar tooth, which has never been found to exceed nineteen or twenty, as against the twenty-four and sometimes twenty-eight in other species. The largest tooth is ten inches in length. The rhinoceri of the Thames Valley are represented by eighty-six remains, of three species, distinguished by the character or the absence of the bony nasal septum—viz., *Rhinoceros megarhinus*, *R. leptorhinus*, and *R. tichorhinus*. The British lion, which recent geology shows to have been no myth, is represented by a lower jaw and a phalanx of the left forefoot. The Brady collection also includes the Thames Valley hippopotamus, which is found at Grays, as well as at Ilford. The ruminants, such as the stag, bison, and ox, constitute fully one-half the collection, numbering more than 500 specimens. They include seven specimens of the great Irish Elk (*Megaceros hibernicus*) and fifty of the Red Deer.

WE learn from the *Lancet* that the sanitary authorities of Leicester have determined to institute an inquiry into the causes and conditions of the high mortality in that town from diarrhœa, and Dr. Beck and Dr. Frankland have been appointed to carry out the inquiry. It was recently shown in NATURE (vol. xii. p. 281) that the average mortality in Leicester from diarrhœa, and among infants, has far exceeded that of any other large town in England, and that whereas the average highest mortality from diarrhœa in any other large town during any week of the year has not exceeded 10·5 on an annual mortality per 1,000 of the population, in Leicester the average reaches 15·8. This large mortality from diarrhœa has been a characteristic of Leicester each year since the Registrar-General began to publish the returns for Leicester in his weekly reports, the distribution of the deaths during the warm weeks and the number being plainly and directly dependent on the temperature. During the six weeks ending 14th August last the deaths from diarrhœa in Leicester have been 121; during the same six weeks of 1874 when the temperature was higher, the deaths were 156. The peculiarity of the mortality of Leicester lies in this: whilst the rate of its infant and diarrhœa mortality is enormously high, its annual death-rate for the whole population is moderately low, being only 26 per 1,000 of the population; whereas in Liverpool and Manchester it is fully thirty, or one-fifth more. Hence, in commencing a scientific inquiry into the causes and conditions of this great destroyer of the infant life of our large towns, no better beginning could have been made than with Leicester. For reasons stated by Mr. Buchan and Dr. Mitchell in their recently published paper "On the Influence of Weather on Mortality" (Jour. Scot. Met. Soc., vol. iv. p. 232), a separation of the infants that die, or are attacked, into three classes—viz. (1) those nursed at the breast, (2) those fed on cows' milk, and (3) those fed on slops—is most desirable in such inquiries, particularly since facts seem at present to point to the intimate bearing, on this vitally important question, of high summer temperatures on milk exposed to them, especially on the small portion of milk which may be carelessly left in the apparatus used in the case of those infants that are fed on cows' milk.

WE have before us three contributions to American Botany:—1. Conspectus of the North American Hydrophyllaceæ, by Prof. Asa Gray. The genus *Eutoca*, well known under that name to flourish in this country, is here merged in *Phacelia*, which numbers about fifty species. 2. Revision of the genus *Ceanothus*, and descriptions of new plants, by Sereno Watson. 3. Botanical observations in Southern Utah in 1874, by Dr. C. C. Parry; a series of papers reprinted from the *American Naturalist*. The south-western portion of the vast territory of the United States has been for some years one of the most fertile portions of the surface of the earth in yielding new species of plants; very little having been done, before Dr. Parry's visit, since the working up by Torrey and Gray of the results of Col. Fremont's expedition in 1844. A very interesting sketch of the botany of the district is contained in these papers, together with notes of many new species described by Prof. Gray and others.

PROF. PALMIERI has discovered a new instrument which he calls a "diagometer," and which is constructed for the rapid examination of oils and textures by means of electricity. What the apparatus will do, Prof. Palmieri details thus:—1. It will show the quality of olive oil. 2. It will distinguish olive oil from seed oil. 3. It will indicate whether olive oil, although of the best appearance, has been mixed with seed oil. 4. It will show the quality of seed oils. 5. Finally, it will indicate the presence of cotton in silken or woollen textures. The professor has been complimented for this invention by the Chamber of Arts and Commerce at Naples, who have published a full description of the apparatus, with instructions for use.

THE additions to the Zoological Society's Gardens during the past week include an Indian Leopard (*Felis pardus*) from India, presented by Mr. G. Jasper Nicholls; an Arctic Fox (*Cani lagopus*) from the Arctic Regions, presented by Mr. C. R. Wood; a Montagu's Harrier (*Circus cineraceus*), European, presented by Capt. Hadfield; a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, presented by Mrs. H. M. Smith; a Wrinkled Terrapin (*Clemmys rugosa*) and five American Box Tortoises (*Terrapene carinata*) from Nicaragua, presented by Mr. Edmond Isaacson; a West African Tantalus (*Tantalus ibis*) from West Africa; two Brazilian Tortoises (*Testudo tabulata*) from South America, an Abyssinian Pentonyx (*Pelomedusa gehafi*) from Abyssinia, deposited; an Indian Fruit Bat (*Pteropus medius*) from India, purchased; a Wapiti Deer (*Cervus canadensis*) born in the Gardens.

SCIENTIFIC SERIALS

THE first fascicule of this year's *Bulletin de la Société d'Anthropologie de Paris* gives the new president, M. Dallas' inaugural address, in which he draws attention, amongst other points, to the importance in reference to anthropology of the study of "demography," or that branch of sociology which treats of the influence of prosperity on populations in determining the maxima and minima of births and deaths. After speaking with just pride of the merit due to the Paris Society of having inaugurated the systematic study of anthropology, and of having served as the model for similar institutions in all the great cities of the old and new Continent, the President announced that in consequence of the appointment of two new secretaries, MM. Astézat and Gerard de Rialle, and of a general-assistant secretary, M. Magitot, as well as through the adoption of different rules for the transmission of papers, the publication of the *Bulletins* would no longer be subject to the delay which had of late years marked their appearance. In the discussion which followed M. de Mortillet's paper on the circles drawn on a fragment of a human skull found in the dolmens of Lozère, M. de Leguay took occasion to express his conviction that the men who constructed these megalithic monuments must have been possessed of tools of metal, and provided with textile fabrics such as strong ropes, capable of being used to lift and pull heavy weights. He does not venture to give an opinion as to the probable antiquity of these remains, but he believes that no one acquainted with practical mechanics can attach faith to the commonly accepted theory that these stones have been conveyed from distances and elevated to their present positions by slides or rollers. The speaker, moreover, pointed to the fact that a bronze bracelet of indisputable Gallic fabrication was found below one of the Lozère dolmens; and he is of opinion that the men who erected the latter used iron as well as bronze.—In discussing the human remains belonging to upwards of 200 individuals found by M. de Baye in the Baye caverns on the Marne, among which were skulls having circular lines and perforations similar to those of the Lozère fragment, M. Broca drew attention to the two distinct cranial types which they presented, the one being dolicephalic, while the other was sub-brachycephalic.—Those interested in abnormal types of humanity will find much suggestive matter in several papers referring to the so-called Aztecs introduced into Europe twenty-five years ago, in whom microcephalism—whatever its cause may be—is more strikingly exhibited than in any other known case.—M. Hamy's learned paper on artificially produced microcephalism among the sacerdotal classes of Central America, gave rise to an animated discussion in which Dr. Broca and Madame Royer took part.—Dr. Mondières has laid an interesting report before the society, in which he supplies much hitherto unknown information in regard to the prevalent diseases of the natives of Cochin China, the remedies applied, and the practices resorted to by the bonzes for working pretended miracles. The author describes the physical characteristics of the two distinct races, the Minghuongs and true Cambodians.—M. Broca exhibited the skeleton of a Peruvian mummy-fœtus which had been taken from an ancient cemetery near Callao, laid bare by an earthquake. It was found in the portion of the ground appropriated to infants, and where each little body was tied tightly into a cloth and had enclosed with it a number of minute toy-like vessels, utensils, and arms. The fœtal mummy was examined with special reference to the existence of the supernumary cranial bone, which some Spanish writers affirm to be a characteristic of the Inca race. No such bone could, however, be detected in the Peruvian mummy, whose skull was precisely similar to those of Europeans at the same period of fœtal existence.

THE *Journal de Physique théorique et appliquée* for July contains the following original papers:—On the acoustic theory of beats, by Terguem and Boussinesq.—On the use of collodion films in Physics, by E. Gripon.—On the interior double reflexion of uniaxal crystals, by M. Abria.—A note by M. Henri Becquerel, on the action of magnetism upon the induction spark.—On a new method to produce sonorous vibrations and interferences on mercury, by C. Decharme.—On the channelled space spectra of MM. Fizeau and Foucault, by M. Nodot.

Gazzetta Chimica Italiana (fasc. vi. 1875.)—This number contains the following papers:—Defence of the old theory of electrostatic induction, by G. Pisati.—Chemical dissociation as applied to the interpretation of some volcanic phenomena; analysis and synthesis of a new mineral from Mount Etna, which is of common origin in volcanoes, by Prof. O. Silvestri.—Experimental researches by Dr. L. Pesci, on peroxide of iron as generator of nitric acid, and on the origin of nitre in some experiments of Cloëz.—Chemical and toxicological researches by Dr. C. Bettelli, on oleandrine and so-called pseudocurarine.—On albumen assisting the solution of the tricalcic phosphate of the blood, by M. Mercadante.—On the presence of leucine in vetches, by A. Cossa.

THE *Notizblatt des Vereins für Erdkunde zu Darmstadt*, series iii. heft xiii. contains but one paper of scientific interest, all the rest of the contents being devoted to statistical reports from the central station for statistics of the Grand Duchy of Hessen, and to tables relating to these reports. The paper referred to records the meteorological observations of the Kataster Office at Darmstadt during the whole of the year 1873, and is accompanied by a very elaborate table.

THE *Journal de Physique théorique et appliquée* for August contains the following original treatises:—On double spectra, by M. G. Salet.—Exposition of some experiments relating to the theory of induction, by M. Felici.—On a new method to determine quickly the refractive index of liquids, by MM. Terquem and Trannin.—On a new form of electro-magnet, by M. A. Camacho.—On elliptic polarisation, by L. Mouton.—The remainder of the journal contains extracts and translations from *Poggendorff's Annalen* and from the *American Journal of Science and Arts.*

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 30.—M. Frémy in the chair.—The following papers were read:—A note by M. Leverrier on Jupiter's mass and on some new researches on Saturn.—On the formation of hail, by M. Faye.—Tenth note on the electric conductibility of bodies known to be bad conductors, by M. Th. du Moncel.—Report by a commission appointed to examine a memoir by M. Haton de la Goupillière, entitled, Direct and Inverse "développoids" of successive Orders.—A note by M. J. Künckel, on Lepidoptera with perforating proboscis as destroyers of oranges (Ophidera).—Remarks on the granitic diluvium of plateaus; lithological composition of the caolinic sand of Montainville (Seine et Oise), by M. Stan. Meunier.—On the germination of Chevalier barley, by M. A. Leclerc.—Researches on the ferments contained in plants, by M. C. Kossmann.—A number of communications of minor interest.—On the formation of aniline black, obtained by the electrolysis of its salts, by J. J. Coquillion.—On the development of unfertilised ova of frogs, by M. G. Moquin Tandon.

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THURSDAY, SEPTEMBER 16, 1875

THE SCIENCE COMMISSION REPORT ON THE ADVANCEMENT OF SCIENCE[*]

WE pass now to the fourth and last head, which deals with

The Central Organisation which is best calculated to enable the Government to determine its action in all questions affecting Science.

The Commissioners discuss two questions separately under this head. (1) The appointing of a Minister of Science. (2) The establishing of a Council of Science.

Extracts from the Evidence relating to the Appointment of a Minister of Science.

The Commissioners observe—

"We have received a large amount of evidence in favour of the appointment of a Minister of Science. There has been almost complete unanimity among the witnesses on this point."

Indeed, the necessity for such a minister is the one theme never lost sight of throughout the bulky volume of evidence. Scarcely a proposal is made which does not either involve or imply this necessity. Expunge all the recommendations that a Minister of Science should be appointed, and there will scarcely remain a recommendation that can be practically carried out, or that is not, on its face, almost a confessed absurdity.

The extracts which we append from evidence on this question form but a very small portion of the representations submitted to the Royal Commission, of which they must be considered only samples.

Prof. Owen:—

"I conceive that the recommendation by Bentham in the last century of such a minister can hardly fail to be practically adopted before the close of the present century, and that the necessity of having a minister for such a purpose will be recognised."

Sir W. Thomson:—

"Would you contemplate that a new department of the State should be constituted for directing the scientific work of the Government?—It would be quite necessary to have a Minister of Science; it is indeed, I think, generally felt that a Minister of Science and scientific instruction is a necessity."

"Not a minister of other instruction?—Specially of scientific instruction, and not under any national education board, but a minister of science and scientific instruction. The minister would necessarily be in Parliament and a political man, but it would be very rare that he could also be a scientific man, and perhaps not desirable that he should be a scientific man, but he must have able scientific advisers always at hand."

"Could any such duties be well assigned to any existing department of the State?—I believe not."

"You spoke of the necessity for having a Minister of Science; do you conceive that it would be requisite to have a cabinet minister for education and a second cabinet minister for science, or would you contemplate that the minister for education should be the minister for science?—I do not wish absolutely to fix it beforehand; on the whole I think, however, that the title of Minister of Education would not suffice. If there is to be a minister it must be a minister of science and education. There might be a minister of science and education, with a chief secretary or under minister for national and elementary education, and another for the advancement of science and for the higher scientific instruction. But naturally the minister of education must act for the masses; that must be his great duty, and however much he might wish to act for science, he has still a great duty to the masses. On the whole I think it would be preferable to have a distinct minister of science and scientific instruction. A minister of science and scientific instruction, as a subordinate to a chief minister of science and education, might probably be a very good arrangement.

"The Minister of Science administers knowledge to the whole country."

Col. Strange:—

"It seems to me that in the first place there should be some means of bringing science fully before the nation through Parliament. I know of no means of doing this that is in accordance with our constitutional procedure, except through a minister of State; and therefore assuming science to be a matter of enormous national importance, I think it is essential that it should be all brought under one minister of State, who should be responsible to Parliament for everything which is done in the name of the nation to further science, and who should frame his own estimates and keep them distinct from those of departments which have little or nothing to do with science. . . . . I think that there should be an estimate for science just as there is an estimate for the army and for the navy. . . . .

"What I should be glad to see would be a minister for science; but I dare say that if proper assistance were given to such a minister, he might superintend other departments as well; for instance, as on the Continent, he might superintend education and the fine arts. I think it would be preferable that he should be for science only. I think there is quite enough for him to do in England, for it to be done thoroughly; but rather than have no minister I would assign to him also education and the fine arts."

"There would be a difficulty, would there not, in defining the boundaries between the duties of the minister for science and the minister for education?—I think not. I think one would relate to education, which is quite a distinct thing from national research, and I think that they should be kept as distinct as possible. I think one great evil now existing is the mixing up of those two things. Throughout my evidence I have here and there expressed the same opinion that they should be kept distinct, one being the means, the other the end; instruction I conceive to be the mode of growing a certain number of persons fit to investigate."

Mr. De la Rue:—

"I think that science ought to be recognised in the Ministry by the appointment of a Science Minister, in order that all matters relating to science might come properly under the cognisance of the Government, and that whenever the Government sought the aid of scientific men it should be through the intervention of the Science Minister. . . . ."

Mr. John Ball:—

". . . . If science is to be aided effectually, and at the same time controlled effectually, there should be some permanent officer in the department of the Government that has its relation with science, whose duty it should be and who should be responsible for making himself generally aware of the state of science and the doings of its cultivators, and who should be the proper person to advise the Government, not as to the best mode of deciding a strictly scientific question, but as to where the means for solving it are to be had. I look upon it at present as being a wholly haphazard matter how questions of science or connected with science and affecting the progress of science are decided in the public offices, and I speak from some slight personal acquaintance with the matter during the short time that I was in the public service in Parliament."

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[*] Continued from p. 392.

"You stated, did you not, that you thought it desirable that there should be some permanent official to represent and advise the Government in its relations to science?—Decidedly."

General Strachey:—

"The first conclusion that I arrive at is that all questions relating to scientific matters that arise in the operations of the Government should be dealt with by one of the chief ministers of the Crown, and the officer at the head of the Education Department seems to be the most suitable of such officers. It has been, I know, suggested by some persons that it would be better if there were a separate department for science. That I venture to doubt. . . . .

"Under such an education and science department there would be a natural division of the duties, which would probably lead to the appointment of some permanent officer in the position of an under secretary of State, who would have specific charge of the scientific duties of the department as distinguished from the educational duties, which constitute a distinct branch of administrative work. . . . .

"The principal officers in the proposed scientific branch of the department should be, by their scientific qualifications, capable of disposing of the ordinary current business under their charge. . . . ."

Dr. Sclater:—

"Do you agree with [Col. Strange's] views as to the creation of a Minister of Science and a Council of Science?—Yes, I agree generally with his views; I think that it would be very desirable for the interest of science."

"Do you think it would be desirable that the existing State scientific institutions should be removed from the control of the Admiralty, the Office of Works, and other departments under which they are now placed?—I think it would be a very great advantage that they should be removed from those departments and placed under one minister."

"Have you any opinion as to whether the work could be done by a Minister of Education, supposing such a minister were appointed?—I think it would hardly be expected that a minister should be appointed only for science; and as I believe it is the case in continental countries that that department is given to the Minister of Education, I think that we could not follow a better example here."

Prof. Balfour Stewart:—

"I think it [the Ministry of Science] might form a division, perhaps, of the Ministry of Education."

Mr. Farrer:—

"I dislike very much the idea of establishing new departments of the Government. If it were possible that this business could be placed upon the Minister of Education, who is becoming more and more important, I think that would be much better than establishing a separate department for the purpose."

Sir George Airy is perhaps the only witness of authority who does not seem able to perceive that any advantages would follow the creation of a Science Minister. The following is his evidence on the question:—

"Do you see any inconvenience arising from the several scientific institutions that are more or less connected with the Government being under different departments?—Not that I am aware of."

"You are content that the Royal Observatory at Greenwich should remain under the Board of Admiralty. You do not require to have a Minister of Science, or a Minister of Education?—No; we are naturally connected in these respects with the Admiralty. . . ."

The Astronomer Royal appears to have confined his attention to the wants of the great Observatory of which he has so long been the distinguished director. It is to be regretted that he abstained from enunciating his views on the larger question of the administration which an extension and systematisation of national science would render necessary.

The Proposal to establish a Council of Science.

A proposal to establish a Council of Science was brought before the Government by the Royal Society in 1857, upon a Report from the Government Grant Committee of that society.

The object of the Committee was (evidence of Sir E. Sabine, qu. 11,117) to determine "whether any measure could be adopted by the Government which would improve the position of science or its cultivators in this country."

This Report, after enumerating the various matters connected with science which should properly come under the supervision of the Government, concludes by naming two bodies under whose advice that supervision might be conducted. They say:—

"11. Assuming that the above proposal should meet with the approval of her Majesty's Government, it will be desirable to ascertain what mode of constituting such a board would inspire them with most confidence in its recommendations. Two modes may be suggested in which such a board might be organised. First, the Government might formally recognise the President and Council of the Royal Society as its official adviser, imposing the whole responsibility on that body, and leaving it to them to seek advice when necessary in such quarters as it may best be found, according to the method now pursued in the disposal of the Parliamentary grant of 1,000*l*. The second method would be to create an entirely new board, somewhat after the model of the old Board of Longitude, but with improvements. The question as to which alternative shall be adopted is properly a subject for the consideration of the Government."

Upon this the Commissioners state as follows:—

"The proposal to establish a Council of Science has recently been revived by Col. Strange.

"Amongst the witnesses who recommend the appointment of a Council, there is a great diversity of opinion as to its constitution and limits of action. As regards its constitution, it will be seen from the summary of evidence which we shall give subsequently, that while some of the witnesses are in favour of a Council very limited in numbers, others would desire to have it sufficiently numerous to include representatives of nearly every branch of science, as well as men of known administrative ability.

"In regard to its limits of action, the main difference arises on the two questions, whether the Council should or should not have the power of initiating inquiries, either directly or by suggestion to the Minister, and whether or not it should itself undertake the actual work of investigation required for State purposes.

"As to the mode of remuneration, the opinions vary between those which advocate annual payments to permanent officials, and those which are in favour of payments for attendance at meetings.

"The opinions of the witnesses who are opposed to any such Council are based, in the main, upon one or more of the following objections:—

"1. That Government can get the best advice without it.

"2. That it would be liable to come into collision with Ministers.

"3. That it would not work harmoniously with our general system of administration.

"The evidence of three eminent statesmen possessing great administrative experience—Lord Derby, Lord Salisbury, and Sir Stafford Northcote—is in strong contrast (so far as the proposal to establish a Council of Science is concerned) with that which we have received from many persons holding official positions in various branches of the public service. The opinions of these latter, as to the inefficiency of the organisation of their respective services in regard to questions affecting science, we have already quoted in the first part of this Report, and it will be seen from the quotations we are now about to give, that they in general consider the creation of a Council to be the proper remedy."

The Commissioners preface their extracts from the evidence laid before them on this subject by saying :—

"We fear that no mere extracts from the evidence of Col. Strange would represent in an adequate manner the views which have led him to recommend the formation of a large and highly-paid Council of Science. It would scarcely be fair to him, as the most prominent advocate of the proposed measure, to do otherwise than refer to his evidence at length, pp. 75 to 92, and 125 to 135, vol. ii. of Evidence."

When we say that Col. Strange's evidence constitutes a complete and carefully arranged scheme for the scientific administration of the country, it will be readily understood why the Commissioners refer to it as a whole, rather than cite detached portions of it from which no conception of its systematic and comprehensive character could be formed. With respect to the Council, Col. Strange first points out its necessity and then defines its functions. His next step is to so construct it as to fit it for performing these functions satisfactorily. And finally, he enters fully into the mode of its election, its remuneration, and its relation to the Minister of Science and to the various departments and institutions concerned with scientific questions.

Though, like the Commissioners, we find it impossible to give a just idea of this scheme by means of extracts, we think that as the composition of the Council suggested by Col. Strange was made by the Commission the foundation of their examination of almost every witness who spoke on that subject, it is desirable that the sketch of Col. Strange's Council should precede the short extracts from evidence on the subject which we shall lay before our readers. It stands thus :—

Sketch of Proposed Council.

Pure Mathematician (the Professor of Mathematics at Oxford and Cambridge alternately. These should be "Regius Professorships")	1
Mixed ditto (Astronomer Royal for the time being)	1
Chemists (one to be the Director of the proposed Chemical Laboratory)	2
Meteorologist (Director of Meteorological Department)	1
Physical Astronomer (Director of proposed Physical Observatory)	1
Metallurgist (Director of proposed Metallurgical Laboratory)	1
Geologist (Director of Geological Survey)	1
Physicists (one to be an Electrician)	2
Naturalist (Head of Natural History Department of British Museum)	1
Physician (Medical Officer of the Privy Council)	1
Surgeon	1
Physiologist	1
Naval Architect	1
Civil Engineer	1
Mechanical ditto	1
Mining ditto	1
Statist	1
Royal Engineer Officers	2
Royal Artillery ditto (one for Field Artillery, the other for heavy Ordnance)	2
Royal Navy ditto (one for Navigation, the other for Gunnery)	2
Infantry Officers	2
Merchants (one a shipowner)	2
Agriculturist	1
	30

Colonel Strange remarks on the above :—

"Of course I give that sketch of the Council as a mere indication of the sort of Council that I think is desirable. It is something that I put before the Commission in order to be torn to pieces and put into shape; it is a mere sketch of a possible Council. I have given it a great deal of thought, and it does not appear to me that there are any superfluous members in it, nor do I know of any that have been omitted. I may say generally that one of my great objects was to place in this Council the heads of institutions, in order that they might be concerned in the directions given to their various institutions. I think it would hardly do (in a former part of my evidence this matter was alluded to) to have a separate body directing men of eminence as heads of institutions; it would be felt to be an interference, but if those heads were part of the governing body, then the interference would not be felt."

Though Colonel Strange's sketch was freely discussed and criticised, no witness pointed out specifically its omissions or redundancies, nor was any definite counter-proposal submitted to the Commission.

Sir W. Thomson's evidence with reference to the establishment of a Council of Science contains the following :—

"Do you think that a single body would be better than a number of small committees for advising the Government on the great variety of questions which from time to time would be likely to arise? Yes, certainly."

"The questions which might be referred to such a Council would differ very much from one another, and extend over a wide range, would they not? Yes, but there would be an unity of design and action, with a multiplicity of knowledge and skill at command, secured by a single Council, and those conditions cannot, in my opinion, be secured at all by occasional committees, or committees working separately and independently of each other. . . .

"A scientific Council would relieve the Government of all responsibility in such matters, and would be responsible itself in a general way for all its proceedings to a political chief and to Parliament. . . ."

"Would you be so good as to inform us whether you have formed any opinions as to the best system of appointing such a Council?—The Council ought to represent the different branches of science and the practical applications of science. Pure mathematics ought to be represented in the Council; mixed or applied mathematics, according to the old-fashioned nomenclature as generally understood, ought also to be represented; chemistry cannot be shut out; physics must of course be represented, and ought to be represented separately; astronomy, both what was formerly called physical astronomy and of course the new science of astronomical physics, ought to be represented. I do not believe that astronomy could be properly represented under one head; astronomical physics must, in my opinion, be separately represented. Geology should be separately represented, and also the various branches of natural history; physiology also, and medical practice in general, should be represented. I have spoken of applied mathematics, I meant rather mathematical dynamics than applications to art and mechanical operations. Then practical applications should be represented, mechanics and mechanical engineering; then again civil engineering and geodesy, mining engineering, statistical inquiries, and the scientific branches of her Majesty's service ought to be thoroughly represented. Engineer and Artillery officers and the navy should be represented both in its navigation department and in the department of seamanship, and the department of gunnery. The mercantile interests of the country and the agriculture of the country ought certainly to be represented. The universities ought to be represented amply—the English universities, the Scotch universities, and the Irish universities. Also practical telegraphy, which is a very distinct branch of engineering, civil engineering or mechanical engineering would not sufficiently represent it."

"Do you think that the functions which are proposed to be assigned to the scientific Council would not interfere in any way with the existing scientific departments of the Government; for example, the Medical Department of the Privy Council, or some of the other Government scientific departments?—I think it would relieve the departments from pieces of scientific work at present given to them, because there is no other body to whom they can be given, and for which they are by their organisation and *personnel* almost necessarily ill fitted and insufficiently competent."

"You would leave to these departments their administrative functions, but give them the advantage of consulting with the Council upon higher questions of science on which they desired information?—Yes, certainly; every question of science that falls under the notice of any department of the Government would naturally be referred to the scientific Council."

Dr. Frankland thus deals with Col. Strange's proposal:—

"Are you acquainted with Col. Strange's proposal for the establishment of a consultative council of science?—Yes, I have heard from him some of the chief ideas that he entertains on that subject."

"Are you disposed to consider that such a Council would be desirable?—I think so. I am not prepared to say that it should be constituted exactly in the way that Col. Strange mentioned, but a Council of that description would be exceedingly desirable, on many grounds, for furnishing the Government with trustworthy scientific opinions in cases requiring them. . . ."

"Are you of opinion that the advice of such a Council, even on matters to which the larger proportion of the members of the Council had not paid special attention, would be valuable?—Yes, I think it would, because those members of the Council who were thoroughly acquainted with the subjects would be expressing their opinion to men conversant with scientific methods, and they would be able to convince their colleagues with respect to the opinion that the Council generally ought to give upon the matter. It would be a very different thing from that of convincing a Parliamentary Committee, for instance, upon a scientific point, because all the men upon the Council would have received a scientific training and would understand the bearing of scientific arguments."

"Have you considered at all how such a Council could best be appointed, whether would you leave it to one of the Ministers to appoint and select the proper persons to serve on the Council?—I should think that it must ultimately fall upon the Minister, but he might be assisted by the presidents of different learned societies or by the Council of the Royal Society, in whom I think everyone would have confidence."

(*To be continued.*)

THE IRON AND STEEL INSTITUTE

EVERY friend of science and true patriot must heartily welcome the sound and steady progress of the Iron and Steel Institute. The proceedings at the Manchester meeting last week, as also its Journal, just received, containing the papers read at the last London meeting, show that it is doing exactly the kind of work which is now becoming quite necessary for the maintenance of the dignity and prosperity of British industry. It also displays a very important feature of industrial progress. One need not be grey-headed to be able to remember when iron-workers and iron-masters, in common with other artificers, were nearly unanimous in believing that their trade interests were best served by each man hugging up to himself every bit of newly acquired trade information, and keeping his competitors as much as possible in the dark respecting it. Indentures of apprenticeship still describe our common trades as "mysteries," and bind the pupil to abstain from revealing the secrets of the craft which his master solemnly agrees to communicate in return for the premium and seven years' servitude. The ceremonials, secrets, and degrees of freemasonry are based on the old practice of hoarding the arcana of a "craft" and communicating them in various degrees of profundity to certain privileged individuals, who were bound under dreadful penalties to reveal these sacred mysteries to none but the initiated.

Contrasted with these lingering shadows, these penumbral fringes of the old passing darkness, the meetings of the Iron and Steel Institute are full of hopeful suggestion, by displaying the magnitude of the revolution which modern science is gradually effecting. In the still older and still darker times all knowledge was made a mystery and a craft, and was selfishly held by the initiated few who used it for the oppression of their fellow-men. Abstract or pure science was first thrown open; learned societies were formed for the discovery and diffusion of natural truth by the open and world-wide co-operation of philosophers; their discoveries threw new light into the dark mysteries of trade, and now we see the craftsmen themselves emulating the philosophers, and offering freely to all the world the best results of their technical knowledge, their laborious investigations, and hard-earned technical experience. This is the true chivalry of trade, that only needs its full development in order to place industry fairly upon the throne of its natural and proper dignity.

The Manchester meeting, under the presidency of Mr. W. Menelaus, has been as successful as could possibly have been wished. Although the papers read were too purely technical to be referred to at length in NATURE, still they are all evidences that the iron and steel industries are being more and more rigidly conducted on scientific methods. The papers read were few, but they were all of a thoroughly practical kind, and along with the discussions which generally followed, were well calculated to promote the objects for which the Institute has been established. The first paper read, and which gave rise to a warm discussion, was by Mr. Daniel Adamson on "The Application of High-pressure Steam to Quadruple Engines." Mr. I. Lowthian Bell's paper on "The use of Caustic Lime in Blast Furnaces" is likely to prove of great value to those interested in the subject. The object of the paper was to show that for high furnaces it was unnecessary to calcine the limestone before using it.

Mr. W. Hackney read a paper on the designing of ingot moulds for steel rail ingots. Mr. Hackney has designed a mould in which the outside is rounded, the thickness of the metal being so adjusted at different parts of the circumference that the expansion under heat should be equal all round. This form has given satisfactory results, one proof of its correctness being that when it becomes heated to redness by an ingot of steel cast in it, the temperature of the outside is apparently equal all round.

Mr. Charles Wood described some improvements made by him in the hearths of blast furnaces. Another paper by Mr. Lowthian Bell described Mr. W. Price's retort furnace. In Mr. Price's furnace the temperature of the air, as well as that of the gaseous and fixed constituents of the coal, is raised by the waste heat before it enters the chimney. Mr. Price cannot compete with the Siemens furnace as regards intensity of temperature, but he avoids the loss which occurs in the gas-producers of the regenerative furnaces.

A paper by Mr. C. J. Horner, on the North Staffordshire Coalfields, had to be considerably curtailed, and two other papers had to be taken as read, in order that the excursion programme might be carried out. Indeed, one of the chief objects of the autumn meeting of the Institute is to visit places of interest from an industrial point of view, and hence the number of papers read is generally limited. This year the visits and excursions were very numerous indeed to industrial establishments in and around Manchester, and all of them seem to have been completely successful. Our space does not permit us to give a detailed account of these excursions, although many of the processes witnessed by the visitors were of considerable scientific interest. The meeting was brought to a successful termination on Friday by a visit, which formed, indeed, a hard day's work, to the North Staffordshire iron and coal district. From first to last the members of the Institute have good reason to be satisfied with the Manchester meeting.

In conclusion, we must express a hope that ere long our other great industries will follow the example of the iron and steel trade in forming their own special technological Institutes and holding meetings and publishing records of similar character and value to those of the Iron and Steel Institute.

RUTHERFORD'S "PRACTICAL HISTOLOGY"

Outlines of Practical Histology. By William Rutherford, M.D. (London: J. and A. Churchill, 1875.)

OF the different methods whereby the standard of scientific education is capable of being elevated, few will not place foremost the extension of theoretical studies into first principles and collateral branches which have a bearing, ever so little as it may appear to be, on the main subject. How much, for instance, does physiology suffer from a deficiency in mathematical and physical knowledge on the part of many of its most enthusiastic devotees. A wider general acquaintance with chemistry would, also, not be out of place. Practical aptitude and experience no doubt stand next in importance. A mastery of the methods by which what is already known has been arrived at cannot but be one of the best trainings for original investigation. How many a valuable suggestion has been allowed to drop undeveloped, simply because of a want of manipulatory skill on the part of the deviser, whose love for the conception of his own brain is the only sufficient stimulus towards the realisation of its importance, and the working out of its details. All attempts to raise the standard and develop facilities for practical education deserve special attention. The work before us is one of the best of these.

The Notes on Practical Histology were published originally in the *Quarterly Microscopical Journal* for January 1872. Several additions have been made, and various fresh methods have been introduced. As it stands, the work contains all the information on the subject necessary for the student of medicine; and we are certain that anyone who has mastered its details will be in a fit position to undertake high special investigation under favourable auspices. It is evident in every page that Prof. Rutherford is thoroughly master of every method he explains, as much from the minuteness of the detail into which he enters, as from the manner in which matter the least irrelevant is omitted. This is nowhere better seen than in the sections devoted to the "preparation of tissues previous to their examination," which, within a few pages, states exactly what is to be done in the way of preparation and preservation with the body of an animal, such as a guinea-pig, in order that all its tissues and organs, extending to such minutiæ as the structure of the cochlea, shall be in a condition most favourable for detailed investigation.

The book is divided into two parts. The first of these treats of the microscope itself, together with the method of using it; which account is followed by a series of histological demonstrations, explaining the manner in which each tissue and organ of the body must be manipulated in order to show its minute anatomical features. The following is an example under the head of *Nerve Tissue.* "The fibrillar structure of the processes of nerve-cells may be shown as follows. Cut the fresh spinal cord of a calf into pieces about a quarter of an inch in length. Place these for a month in a one per cent. potass. bichrom. solution. Remove a thin slice of the grey matter of the anterior horn with scissors, tease with needles, stain with carmine, and mount in glycerine." Among other special processes described, we find a novel one devised by Dr. William Stirling for exhibiting the structure of skin, which consists in partly digesting it, when stretched, in an artificial peptic fluid, and then staining. By so doing "the white fibrous-tissue swells up and becomes extremely transparent, thus permitting of a clear view of the other tissues." Dr. Urban Pritchard's method of exhibiting the structure of the organ of Corti is also fully explained.

The second part of the book consists of general considerations regarding histological methods. In it the relations of the tissues to surrounding media, the methods of hardening tissues (including the employment of the excellent freezing microtome introduced by the author) and of softening them, are fully explained; as well as are the composition of the best staining fluids, and the most efficient means of preserving microscopic preparations.

One of the most important novel points of manipulatory detail which we notice, is the value of mucilage as an imbedding agent when the microtome is employed for freezing, as suggested by Dr. Pritchard. It depends on the fact that "frozen mucilage can be sliced as readily as a piece of cheese," a most valuable property, as all who have had any experience will acknowledge.

Prof. Rutherford has supplied a deficiency. He has given us a manual which will meet the requirements of a large class of students who will never find it necessary to enter into the details of practical histology so minutely as they are discussed in larger works, such as the "Handbook for the Physiological Laboratory," or the still deeper manual of Stricker.

OUR BOOK SHELF

A Yachting Cruise in the South Seas. By C. F. Wood. With six photographic illustrations. (London: King and Co., 1875.)

MR. WOOD'S narrative is so interesting that we wish it had been very much longer. He has made several voyages among the Pacific Islands during the last eight years, and, judging from this and what he tells us in the work before us, he must possess much valuable information concerning these islands, and especially with regard to their puzzling populations, which he would do well to publish in detail, and which would be welcomed especially by ethnologists. Mr. Wood is evidently a careful observer, and has the power of describing what he observes interestingly and clearly.

The present volume contains a narrative of a cruise which the author made, starting from New Zealand, from May to December 1873, among some of the most interesting groups of the Pacific Islands. Among the islands visited during this time were Rotumah, to the N.E. of Fiji, Futuna, Savaii, and Upolu, in the Samoan group; Niuafu, some of the islands in the Fiji group, the New Hebrides, the Solomon Islands, the Caroline Islands, Oualan, the Mulgrave Islands, and the Ellice group. Concerning every island which he visited, Mr. Wood has some interesting and valuable information to give, either about its physical condition, its products, its people, its history, or its antiquities. One of the main objects of his cruise was the collection of native implements and weapons, and in this he seems to have succeeded to his heart's content. His observations concerning the people seem to us especially valuable; he has gathered many traditions as to their migrations, and gives some specimens of folk-lore. In many of the islands the natives seem restless and discontented, and Mr. Wood was frequently petitioned to give them a passage from one island to another. Like many other Pacific voyagers, he has but a poor opinion of the results of the attempts which have been made to Christianise the natives. Not that he disapproves of attempting to civilise them and to raise them in the scale of humanity, but he thinks the methods which are generally adopted are quite abortive. The unmodified European garment of civilisation evidently cramps and enervates the Pacific Islander.

The information which Mr. Wood gives concerning the Rotumans, their traditions as to their predecessors in the island, their migrations, customs, superstitions, folk-lore, &c., is especially valuable. He refers briefly to the remarkable mounds among the hills in Bonabi, or Ascension Island, in the Caroline group, about which them have no tradition, but which would be likely to repay a careful examination. Quite as interesting, and still more wonderful, are the remains of large buildings of stone in the same island, some of the blocks of which are of immense size, and concerning which also the natives seem to have no traditions. Mr. Wood believes these ruins to be the work of a people that have passed away, and it is very unlikely that the original buildings were the work of passing Spaniards, as has been supposed. We have certainly much yet to learn concerning the history and relationships of the Pacific Island populations, and it is a subject well worth careful investigation. Mr. Wood's modest volume is a valuable, though small, contribution to our knowledge of the subject; he must, we should think, have a great deal more to tell as the result of his long intercourse with these islands. The few autotype illustrations are appropriate and well executed.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Living Birds of Paradise in Europe

WE have just received at the Zoological Gardens of Dresden two living Birds of Paradise, viz., *Paradisea papuana*, from New Guinea, and *Paradisea apoda*, from the Aru Islands, both males, in excellent health and fine condition. Mr. von Below, Assistant-Resident of Makassar, in Celebes, brought them home in a three-months' passage from Makassar, *viâ* Java, Suez, Gibraltar, London, and Hamburg to Dresden, where he intends to spend the winter, and has deposited the birds in the Zoological Gardens. They have already been about three years in captivity with him at Makassar, where I saw them when passing through that place to New Guinea in 1873. The birds, therefore, are accustomed to cage-life, and as the conditions under which we have placed them are most favourable—consisting chiefly in a large space to allow free movement, and in an equal temperature of about 20° Réaumur—there is some hope of our being able to keep them alive. Mr. von Below got these birds through native traders who have their home at Makassar and trade to New Guinea and the Aru Islands. He fed the birds in India with grasshoppers, bananas, and rice, and on board the steamers with the same, cockroaches being substituted for grasshoppers. In Dresden we try to feed them with bread, rice, and worms (*Mehlwürmer*). Both are very active, and cry their well-known "wôk, wôk" with much force; the specimen of *Paradisea apoda* especially is not the least shy, and takes the worms out of one's hands. Their fine plumage suffered, of course, on the voyage, but I was astonished to see that it was not damaged more. As they probably will moult from about November till April, the plumage will not be at its finest condition till the month of May, and, supposing that the readers of NATURE will be interested in the further fate of these Birds of Paradise, I shall report in time how they are getting on.

I believe I am not mistaken in saying that a living specimen of *Paradisea apoda* has never before been alive in Europe. The two Birds of Paradise which Mr. Wallace brought home, which he had bought at Singapore, were *Paradisea papuana* (if I remember correctly, having no books at hand here); Mr. Cerrutti, some years ago, brought over a specimen of *Seleucides alba*, but I did not hear how long it lived in Europe. No other species of Birds of Paradise have yet been brought alive to Europe, so far as I know, and we may therefore felicitate Mr. von Below on having increased the number of these at least to three.

The inhabitants of those parts of New Guinea which I visited in 1873 are not accustomed to catch *Paradisea papuana* alive, as Mr. Wallace states is the case with *Paradisea apoda* from the Aru Islands; they only know how to kill the bird with the arrow, and I did not succeed in teaching them otherwise, but I suppose that the Papooas of the south-west coast of New Guinea know how to catch the Birds of Paradise alive, and that Mr. von Below's specimen is from that part of New Guinea.

Wildbad Gastein, Sept. 11 A. B. MEYER

Source of Volcanic Energy

MR. W. S. GREEN, like others of Mr. Mallet's supporters, takes wider ground than he did himself in his original paper. It is obvious that he regarded his experiments conclusive as to the amount of heat that could be produced by rock crushing

His advocates, however, and he himself in his later papers, appeal to pressures within the earth enormously greater than those obtained by the mechanical contrivances used, and consider that proportionately greater heat may be evolved.

My "Remarks" at the Geological Society, now published in *The Journal*, were primarily framed with reference to Mr. Mallet's paper as it stood, although I think they are a tolerably satisfactory reply even to the theory as now extended. I have, however, lately gone into the question on first principles, and have satisfied myself that, accepting the conditions lately assumed by Mr. Mallet as a basis, the theory can be shown to be untenable. I hope that a paper containing the grounds of my conclusion will shortly appear.

I am unable to understand how Mr. Green proposes to account for the development of forces as productive of heat through means of "the gravitation of the whole mass" (of the earth) "to itself," otherwise than by "the gravitation of the surface upon a retreating nucleus;" because, unless room be given by a retreating nucleus for the parts to descend, there can be no motion, and consequently no heat. O. FISHER

P.S.—Upon further consideration of Mr. Green's letter, it strikes me that he has misunderstood my meaning in a way that I did not at first perceive. He says that I "object to the possibility of assuming high *local* temperatures to be produced by the transformation of tangential forces into heat within the earth's crust;" as if I objected to any localisation. What I did object to was, not a localisation of work and heat, but a localisation within a localisation, such that the heat of crushing a certain localised volume should fuse a further localised portion of the crushed volume.

Harlton, Cambridge, Sept. 11

Important Discovery of Remains of *Cervus megaceros* in Ireland

DURING 1847, when draining a bog at Kellegar among the Dublin mountains, as many as thirty heads of *C. megaceros*, together with a perfect head and antlers of a Reindeer, were discovered in a cutting of about 100 yards, by 3 yards in breadth. They were found as usual in the marl and clay under the bog. I visited this locality in March last, and from the aspect of the ground and evidence of a farmer who remembered the spot where the above were dug up, it seemed probable that by running a series of trenches parallel with the original ditch made in 1847, fresh exuviæ might be discovered. The subject was accordingly brought to the notice of the Royal Irish Academy, and a grant of 25*l.* obtained. The result has been the finding of about thirty additional heads of *Cervus megaceros*, besides numerous detached bones not yet fully determined.

Mr. R. J. Moss, Keeper of Minerals in the museum of the Royal Dublin Society, who volunteered to conduct the explorations, writes to me that he found the remains embedded in about two to three feet of clay, and often either lying on or impacted between blocks of granite as if they had been drifted into the above situation. A log of oak three feet in length was discovered among the bones in the same stratum of clay. In this instance, as generally obtains in Ireland, the cervine exuviæ are met with around the margins of the bogs, and not in the middle, as if the animals were mired in shallow water, or else their carcases had drifted with the winds or currents to the sides and outlets of the lake. Mr. Moss had to stop excavations in consequence of the grant having become expended, so that doubtless many more remains await further explorations.

This is not the only case known to me of the accumulation of carcases in a small space. I just lately examined a large assortment of skulls and bones of *C. megaceros* dug out of a bog on the property of Mr. R. Usher, of Cappagh, near Dungarvan. These were collected in a space of about 100 yards in length and 70 yards in breadth. They include heads and cast antlers of no less than fifteen individuals of the great horned deer (*i.e.* thirteen male and two female skulls), besides the cast antler of a Red Deer. The above were likewise found more towards the side than the centre of the marsh.

It seems difficult to account for these accumulations of deers' carcases, unless we suppose that a herd was mired on attempting to cross the lake. The fully developed burr of the antler so generally observed on this deer's horns discovered in the mud of ancient lakes might indicate that their owners perished in autumn during the rutting season, when doubtless many far grander scenes than those depicted in the "Challenge" and Wolf's "Race for Life" occurred along Irish lakes. The Bear and Wolf being the only large carnivores in Ireland during the Pleistocene period may account for the abundance of *C. megaceros*; moreover, we have it on historical evidence that the Wolf was extremely common during the seventeenth century, and it is probable, having neither the Hyæna nor the large Felidæ to compete with, that it might have hunted the great horned Deer into the lakes, where many would have got mired in the deepening mud along their margins. A. LEITH ADAMS

Magnus's "Elementary Mechanics"

WITH reference to the favourable notice of my "Elementary Mechanics" which appeared in last week's NATURE, I shall be glad if you will permit me to state that the second edition of my book is already in the printers' hands, and that the few errors, chiefly clerical, in the answers to the examples, which you were good enough to point out, are therein corrected.

London PHILIP MAGNUS

Sanitary State of Bristol and Portsmouth

YOUR correspondent, Dr. Black, in accounting for the uniformly low death-rate of Portsmouth, has, I venture to suggest, omitted two somewhat important coefficients. The one is a thorough and well-planned system of drainage and outfall, completed some few years since at a cost of about 150,000*l.*; the other is the presence of a floating population of several thousand healthy adult males in the shape of the garrison and the sailors.

E. J. E.

Lancaster Gate, W., Sept. 11

OUR ASTRONOMICAL COLUMN

BINARY STARS.—Mr. J. M. Wilson has communicated measures of Σ 2107, 44 Bootis, and ζ Aquarii, made at the Temple Observatory, Rugby, in 1871-75, from which the following are selected:—

Σ 2107	1872·49	Pos.	210°·0	Dist.	0″·77	
	1873·48	,,	207 ·5	,,	0 ·7	est.
	1874·65	,,	208 ·4	,,	0 ·7	est.
	1875·58	,,	215 ·5	,,	0 ·5	est.
44 Bootis	1873·25	,,	240 ·6	,,	5 ·3	
ζ Aquarii	1873·79	,,	335 ·1	,,	3 ·58	

The binary character of the first of these stars is well supported by Mr. Wilson's measures; the angular velocity appears to have regularly increased since about the year 1850, due allowance being made for the difficulty of the object. Struve's first epoch (a correction being made to the time as printed in "Mensuræ Micr.") is

1829·01 Pos. 148°·6 Dist. 1″·127

A discussion of the elements of the orbits of σ Coronæ, τ Ophiuchi, γ Leonis, ζ Aquarii, and 36 Andromedæ, by Dr. Doberck, of Col. Cooper's Observatory, Markree, forms Part 19 of volume xxv. of the *Transactions of the Royal Irish Academy*. Dr. Doberck employs the graphical method proposed by Sir John Herschel, which has been so generally applied, at least in the earlier part of the work. Correction of the approximate elements thus obtained by equations of condition will lead to satisfactory results where there are reliable single epochs, or a sufficient number of contiguous ones, to enable us to form normals. It may be questioned whether the additional labour of calculation which some of the methods of calculating double-star orbits that have been proposed necessarily involve, is rewarded by more satisfactory results than can be obtained by the application of Herschel's graphical process in the first instance, following up by equations of condition.

THE ZODIACAL LIGHT.—During the past week has appeared *Zodiacallicht-Beobachtungen in der letzten* 29 *Jahren* 1847-1875, by Prof. Heis, forming the first special publication of the Royal Observatory of Münster. It contains in considerable detail, but on a systematic plan, the particulars of the numerous observations made by

Heis himself, with a large number by Eylert, Weber, and others, and is a most valuable addition to the observational results bearing upon this, as yet, little-understood phenomenon. We may remind the reader who is desirous of fully acquainting himself with the literature of the subject, that Dr. Julius Schmidt, now Director of the Observatory at Athens, published in similar detail his observations of the zodiacal light in the years 1843-55 (*Das Zodiacallicht*, Braunschweig, 1856).

THE NEXT RETURN OF ENCKE'S COMET.—The appearances of this comet at nearly ten-year intervals in 1819, 1829, 1838, 1848, 1858, and 1868 took place under circumstances which were more or less favourable for observation in this hemisphere; these conditions, however, will not attend the ensuing return to perihelion, which, with the mean motion found by Dr. von Asten for 1875, neglecting the small effect of perturbation, would occur about the 27th of July, 1878; and if the path in the heavens be calculated on this assumption, it will appear that observations will hardly be practicable except in the southern hemisphere in August. The nearest approach to this track is that which the comet followed in 1845, when a few observations only were obtained with difficulty at Rome, Washington, and Philadelphia. With regard to the effect of perturbation upon the length of this comet's period since the year 1819, when its periodicity was first detected, it may be remarked that the longest revolution was that from 1842-45, which extended to 1215·6 days, and the shortest, that from 1868-71, 1200·2 days; difference of extremes, 15½ days.

COMET 1874 (III.), COGGIA.—A third computation of the orbit of this fine comet, founded upon observations between April 20 and July 16, by Herr Geelmuyden, of Lund, has resulted in an ellipse with a period of 10,445 years, confirming the great length of the revolution which resulted from the calculations of Prof. Tietjen and Herr Schulhof. There appears to be no probability of the comet having previously visited these parts of space within historical times.

THE LATE PROF. ARGELANDER.—The last part of the *Vierteljahrsschrift der Astronomischen Gesellschaft*, x. Jahrgang, Drittes Heft, contains an interesting memoir of this distinguished astronomer by his successor, Prof. Schönfeld. As an authoritative summary of his long and laborious services to sidereal astronomy in particular, this memoir will be found a useful reminder. Argelander was born at Memel on March 22, 1799, and died at Bonn on February 17, 1875. His first astronomical observation is stated to have been one of the occultation of the Pleiades on August 29, 1820.

NOTES ON A SUPPOSED MARRIAGE EMBLEM OF AMERICAN INDIAN ORIGIN

A REMARKABLE form of "Indian relic," varying somewhat in details, but having much in common, and never approaching any other stone implement or ornament, is occasionally met with in the "finds" of the Atlantic coast States and westward to the Mississippi. In New Jersey they are less abundant, I believe, than in the States west and south, but a sufficient number of them have been gathered by myself and others to indicate their having been, at one time, a marked feature in the dress of our aborigines.

This "relic," however varied in its outline, always suggests a brooding bird, especially when in the position in which it is placed in Fig. 1. So far as I have made examination of these specimens, and met with notices of them in various publications, they are all manufactured from comparatively soft stone, are accurately outlined, highly polished, and drilled diagonally at the lower corners.

Of the many suggestions made as to their significance, as knife-handles, corn-huskers, idols, &c., I have met with but one that seemed at all probable; and this, I think, is rendered the more probable from circumstances connected with the discovery of various specimens, and certain peculiarities of the fragment of one here figured (Fig. 2).

Writing of one of these relics, Mr. Henry Gillman, in the Smithsonian Annual Report for 1873, p. 371, states: "I have learned, through an aged Indian, that in olden time these ornaments were worn on the heads of Indian women, but only after marriage. I have thought that these peculiar objects, which are always made of some choice material, resemble the figure of a brooding bird; a familiar sight to the 'children of the forest;' that thus they are emblematic of maternity, and as such were designed and worn."

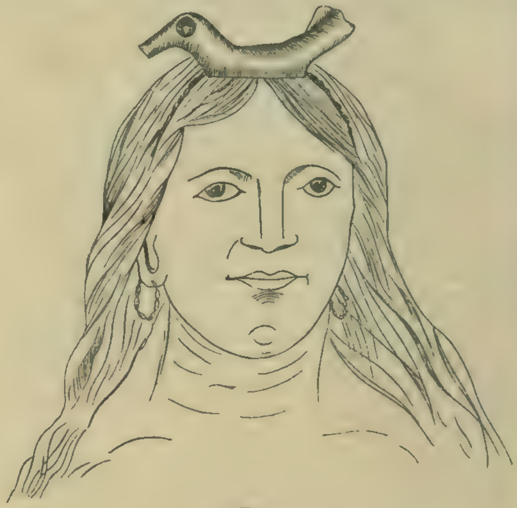

FIG. 1.

Fig. 2 represents the "tail end" of one of these "brooding birds." Probably broken by accident, whether the head was lost or both halves preserved, it will be seen that the specimen has been considered of considerable value, inasmuch as this half has been carefully squared and polished at the point of fracture, and a hole drilled through it, to enable its owner to suspend her rude bracelet or her necklace. Surely, had the unbroken implement (?) been a knife-handle or corn-husker, the fragment such as is here figured would not subsequently have been utilised as an ornament. If put to so commonplace a use in its entirety, a half of one would have no beauty in it, even in the eyes of a Stone-Age savage. A second noticeable feature of this broken specimen is the series of eight deeply cut notches along the "back," or upper margin. These are cut entirely across the narrow ridge forming the back, and extend equally down either side, as seen in the illustration. If an entire specimen, such as is represented on the woman's head (Fig. 1), is or was worn on the head of an Indian woman, but only after marriage, and so emblematic of maternity, then is it not

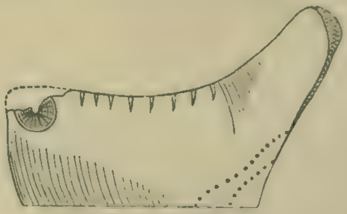

FIG. 2. Natural size.)

reasonable to presume that these marks are records, not merely ornamental lines, and if records, of children born? Such a carved stone, once proudly worn by an Indian of high rank, if broken, as this has been, would naturally be preserved; and that it is but the half of such an one, as seen in Fig 1, is proved by the fact of a hole being drilled in the lower corners, as shown by the dotted lines; a hole that became of no use when the specimen was broken, or at least was less well placed than that subsequently drilled in order to suspend the relic as an ornament, as an ear-ring, or addition to a necklace, as previously suggested.

The traces, as they really are now, of the graves of our aborigines occasionally contain a single specimen of the above-figured relic. So far as I have been able to examine these graves, such relics are never associated with the stone axes and spear-heads characterising the graves of adult males, but simply with other forms of stone ornaments, and a single small mortar and pestle, or earthenware vase. In one instance the "brooding bird" was so placed with reference to the narrow strip of discoloured earth that marked where the body had been laid, as to show conclusively that the relic was attached to the hair, as shown in Fig. 1.

If we examine a series of these relics, it will be at once seen that every one has holes drilled at the lower corners. Such specimens could only be worn upon the top of the head, without being upside down, as would necessarily be the case had they been suspended. It must, too, be borne in mind that these relics are nowhere very abundant, but on the other hand, nowhere unknown north of Mexico. Had they been knife-handles, as suggested by Schoolcraft, or corn-huskers, as suggested by various writers, certainly they would be much more abundant than they really are. Indeed, in considering them as ornaments for married women, I am forced, in consideration of the scanty number that have been collected, to restrict them to women prominent in their tribes, the wives of kings, chiefs, and eminent warriors. If this be true, then the eight birth-records on Fig. 2 are those of "Indian princes," it may be. I must admit, however, that this broken specimen is the only one that I have seen having like marks cut upon it; but such record marks, as I believe them to be, are quite common upon other forms of stone ornaments, particularly those stone tablets and crescents that I have elsewhere (Smithson. Ann. Rep. for 1874) called "breast-plates."

These facts considered, I think that the suggestion of Mr. Gillman, based upon information received from an aged Indian, truly explains what this much-discussed relic truly is—an ornament for married women, an emblem of maternity.

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THE BRITISH ASSOCIATION

REPORTS.

Report of the Committee on Luminous Meteors, by Mr. James Glaisher.—The report related, as usual, to meteors doubly observed, and to aërolites, the portion having reference to the latter being the more interesting, as the falls of aërolites which have been placed on record since the last report were more than ordinarily numerous and interesting. A mass of meteoric iron fell on Aug. 24, 1873, at Maysville, California, and is one of the very few metallic irons the actual descent of which has been witnessed. In the following month a number of meteorites fell near Khairpur, in the Punjaub; and it is also related that in the month of December, when the British army halted on the banks of the Prah, an aërolite fell in the market-place of Coomassie, and was regarded by the native population as a portent of evil. On the 14th and 20th of May, 1874, aërolites fell at Castalia, in North Carolina. The last stone-fall of the past year took place near Iowa city on the 12th of February, 1875, and of this meteorite also special analyses were made in the United States, of which some unforeseen results were lately announced by their author, Mr. A. W. Wright. In England no detonating meteor has been observed this year; and the brightest meteor recorded since the last report occurred on the 1st of September last, taking its course over the north of England, or Scotland, where clouded skies must have prevailed, as its flash was like that of lightning. Other bright meteors occurred on the 2nd and 16th of September, 11th of October, 17th of December, 9th of March, 12th of April, and 2nd and 4th of May in this year. A meteor burst with a loud detonation over Paris and its neighbourhood on the 16th of February; it was of great size and brilliancy, and left a cloud-like streak of light on its track for more than half an hour. No duplicate observation of it was obtained in England. Another fireball fell at Orleans on the 9th of March, and of this two good observations appeared to have been obtained in England, which may assist to determine its real height. During the annual meteor showers of the past year very unfavourable weather generally prevailed for recording meteor tracks, and few meteors were seen on those nights when the usual expectations of their appearance were entertained. A thorough examination of all the observations collected by the committee since the publication of the Meteor Atlas in 1867, with the view of extending and correcting the list of general and occasional meteoric showers which it embraced, has been continued with satisfactory results under the direction of Mr. Greg. The report also contained a *résumé* of the contents of the recent publications on the subject of meteoric astronomy. Mr. Glaisher remarked that the report was the result of considerable labour performed by Prof. A. S. Herschel, but he pointed out that the work of properly treating meteor observations had now become so great as to be beyond the power of the Association to grapple with, and alluded with satisfaction to the arrangements being carried out by M. Leverrier. A discussion took place on the connection of comets and meteors, in the course of which Sir William Thomson said that there was nothing to justify the assertion that the mass of comets was so small as was sometimes supposed, and he considered there was good evidence for believing that the comet's tail was really a train of meteors.

The Report of the Committee on British Rainfall, by Mr. G. J. Symons, began by giving an epitome of the rainfall work done in connection with the British Association during the last fourteen years. It then referred to the steps taken after the meeting at Belfast to obtain additional stations in Ireland, which were so successful that the committee received 190 offers of assistance. The acceptance of all these offers would have involved an expenditure far beyond the funds at the disposal of the committee, and they were therefore reluctantly compelled to make a careful selection, resulting, however, in the establishment of sixty-six stations, many of them in localities of extreme importance. In the past fifteen years the number of stations had been raised from 241 to nearly 2,000. The influence of size and shape on the indications of rain gauges had been experimentally examined, and also the effect of height above ground. The laws which regulate the seasonal distribution of rainfall had been to a certain extent ascertained. The secular variation of annual fall had been approximately determined. A code of rules had been drawn up for observers. Nearly 250 stations have been started at the cost of the Association, and 629 stations have been visited, and the gauges examined by the secretary. They had obtained and supported observations on mountain tops, and places difficult of access where no observations had been made, in Cumberland, Westmoreland, Wales, and Scotland, and also an extensive series in Ireland. When the works actually in hand are completed, they will furnish an index to all the observations hitherto made.

The committee appointed to examine and report upon the reflective powers of silver, gold, platinum, and speculum metal did not present any report, but was reappointed at its own request, with the addition of Prof. Ball.

Owing to the absence of Col. Babbage in India, the committee for estimating the cost of Mr. Babbage's analytical engine had not met, but it requested to be reappointed. No report was received from the committee for the determination of the mechanical equivalent of heat, but it was stated that Prof. Joule's experiments were making good progress. The committee on teaching physics in schools was reappointed. Also the committee for considering the possibility of improving the methods of instruction in elementary geometry was reappointed, with the addition of Prof. Henrici and Mr. J. W. L. Glaisher, and requested to consider the syllabus of the Association for the improvement of geometrical teaching, and to report thereon.

Mr. W. C. Roberts read a note from the committee which had been appointed to investigate *the methods of making gold assays and stating the results.* It stated that the standard gold plate had now been finished, and that portions of it had been forwarded to different mints for the purpose of being assayed. The reports read were very satisfactory, as was shown by the fact of M. Stas, of Brussels obtaining 999·95 parts of pure gold out of 1,000 as the result of an analysis. The same plate had also been examined by Mr. Lockyer by means of the spectroscope, and the lines having been compared with the solar lines, it had been shown that silver, copper, and iron were absent, and that therefore the purification of the metal had been very great.

Mr. A. H. Allen read the *Report of the committee appointed for the purpose of examining and reporting upon the methods employed in the estimation of potash and phosphoric acid in commercial products, and on the mode of stating the results,* in which he stated the object of this committee was to examine all the known methods of analysis of manures and potassium salts. They had hoped to be able now to present to the Section some practical and easy process as a neutral standard of reference by which the present discrepancies might be avoided. The plan adopted by the committee was to draw up a printed list of queries which were sent round to all the members of the Chemical Society, with the request that they would send back answers; this plan had been found to work well with very few exceptions, who declined to give up the processes which they alone employed. The report ended by the committee desiring to be re-appointed, and expressing a confident expectation that by the end of another year some really good results would be obtained.—The President remarked, at the conclusion, that the estimation of potash seemed to present much less difficulty than that of phosphoric acid.

Second Report of a Committee, consisting of Prof. A. S. Herschel and G. A. Lebour, on Experiments to determine the Thermal Conductivities of certain Rocks, showing especially the Geological Aspects of the Investigation.—The experiments during the past year were directed chiefly to a re-examination, with improved apparatus (fully described in the report), of the rocks observed last year. With the exception of Kenton sandstone, which was misplaced in the last table, all the rocks have, under the new mode of treatment, kept the same *relative* positions, and the absolute conductivities given in the present report are believed to leave little or nothing to be desired on the score of accuracy. Quartz has been added to the list, and proves to have less resistance to the passage of heat than any of the other substances examined. Slate has been tried both in the line of cleavage and across it, showing *less* resistance in the latter position than in the former. Some rocks have been experimented on wet as well as dry, the addition of the water giving an increased conductivity of a tolerably constant value. It is intended to continue the experiments in the direction foreshadowed by these results. A full table of absolute conductivities and resistances, with the results of both series of experiments compared, forms part of the report. Coal still maintains its position with the greatest resistance yet found.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS AND PHYSICS

Captain Abney read a paper *On the Increase of Actinism due to difference of Motive Power in the Electric Light,* in which he stated that having been called upon by the War Office to undertake the photometric measurements of certain magneto-electric lights, he had determined to carry out actinic measurements of their value at the same time, believing that the eye observations would be closely checked by such an independent method. In the first comparison of the results obtained by both kinds of measurement, a considerable discrepancy was found to occur in the values given to the different lights. The photographic records could not err except through gross carelessness in the chemical preparations, and against this every precaution had been taken. At first it seemed likely that the eye observations were in fault, but a more critical examination convinced Captain Abney that both were correct; and that though the curves obtained for the values of the lights did not coincide, yet that they did act as a check, the one on the other. In all there were six different machines to examine, each of which was driven by a ten-horse power engine. Several were driven at varying speeds that the difference in the light caused by the variation might be tested.

The eye observations were made by a little instrument called by Captain Abney the Diaphanometer, and described in the *Monthly Notices* of the Astronomical Society for last June. The method adopted for registering the actinic power of the light was by exposing uniformly sensitive chloride of silver paper to the action of its rays. Two registrations were carried out with each light: first, paper was exposed to the naked light at a fixed distance from the carbon points for three minutes; and secondly, a strip of the same paper was exposed beneath black wedges of slight taper for sixteen minutes. The eye observations were carried on simultaneously with the latter exposure of the sensitive paper, in both cases obtaining an integration, as it were, of the light during that period. Between ten and twenty observations were taken for each light at the beginning, middle, and end of each trial. Diagrams of the steam pressure were taken in the usual manner, and diagrams were also taken of the steam pressure when driving the machine without exciting a current, at the same speed as that at which the light was produced. They were also taken in many cases when the machines were what may be called short circuited. The data were thus obtained for calculating the power necessary to produce a light of a certain value.

Diagrams were exhibited showing the mean of the results of a series of experiments with one instrument; one curve, deduced from eighty readings, giving what may be called the optical value; another, deduced from 450 readings, giving the actinic value; whilst a third showed the ratio of the actinic to the optic value—the abscissæ being in all these cases measures of the horse power. The curves are interesting as showing the rapid decrease of the optical value, and still more of the actinic value, of the light when worked with a low motive power. They also show that each machine has a point beyond which the increase in motive power is not compensated for by increase in light, the curves apparently becoming asymptotic.

Captain Abney stated that he was not at all prepared for the great diminution of the value of actinic power in the lights, though he expected it in a smaller degree. The early experiments of Draper and others had shown that with increase of temperature the more refrangible portions of the spectrum appear after the least refrangible, but there seemed to be no measurements which would have been applicable to the present set of experiments. The curves must evidently be some function of the wave-lengths, and the author hoped to carry out other experiments in fixed portions of the spectrum in order to ascertain if the formula which he thought should hold good could be employed.

SECTION B.

CHEMICAL SCIENCE.

OPENING ADDRESS BY A. G. VERNON HARCOURT, M.A., F.R.S., F.C.S., PRESIDENT.

To the privilege of presiding over this Section custom has added the duty of offering some preliminary remarks upon the branch of science for whose advancement we are met.

In discharge of this duty some of my predecessors have reviewed the progress of chemistry during the previous year; and until a few years ago there was no more needful service that your President could render, though the task of selection and abstraction was one of ever-increasing difficulty. But a few years ago the wisdom and energy of Dr. Williamson transformed the Journal of the Chemical Society into a complete record of chemical research, and this Association materially promoted the advancement of science when it helped the Chemical Society in an undertaking which seemed at one time hopelessly beyond its means. The excellent abstracts contributed to the Journal err, if at all, on the side of brevity, and yet the yearly volume seems to defy the bookbinder's press. I shall not venture to attempt further abstraction, nor to put before you in any way so vast and miscellaneous an aggregate of facts as the yearly increment of chemistry has become. The advancement of our science—to borrow again the well-chosen language of the founders of this Association—is of two kinds. The first consists in the discovery and co-ordination of new facts; the second in the diffusion of existing knowledge and the creation of an interest in the objects and methods and results of scientific research. For the advance of science is not to be measured only by the annual growth of a scientific library, but by the living interest it excites and the number and ardour of its votaries. The remarks I have to offer you relate to the advancement of chemistry in both aspects.

One fact has been brought into unpleasant prominence by the Journal of the Chemical Society in its present form, namely, the small proportion of original work in chemistry which is done in

Great Britain. All who are ambitious that our country should bear a prominent part in contributing to the common stock of knowledge, and all who know the effect upon individual character and happiness of the habit and occupation of scientific inquiry, must regret our backwardness in this respect. The immediate cause is easily found. It is not that English workers are less inventive or industrious than their fellows across the Channel, but that their number is exceedingly small. How comes it that in a country which abounds in rich and leisurely men and women—for neither the reason of the case, nor the jealousy of the dominant sex, nor partial legislation excludes women from sharing this pursuit with men—there are so few who seek the excitement and delights of chemical inquiry? Moralists tell us that the reason why some men are content with the pleasures of eating and drinking and the like is, that they have never had experience of the greater pleasure which the exercise of the intelligence affords. I am not about to represent it as the moral duty of those who have means and leisure to cultivate chemistry or any branch of science; but no taste for a pursuit can be developed in the absence of any knowledge of its nature. A taste for chemistry is often spoken of as a peculiar bias with which certain men are born. No doubt there are differences in natural aptitudes and tastes, but the chief reason why it is so rare for men of leisure to addict themselves to scientific pursuits is, that so few boys and young men have had experience of the pleasure which they bring. Much has been done during the last twenty years, both at the Universities and at the Public Schools, to provide for the teaching of science. To speak of what I know best, the University of Oxford has made liberal provision for the teaching of science, and for its recognition among the studies requisite for a degree; nor have the several colleges been backward in allotting scholarships and fellowships as soon as and whenever they had reason to believe that those elected for proficiency in science would be men equal in intellectual calibre to those elected for proficiency in classics or mathematics. But the result is somewhat disappointing, and under a free-trade system science has failed to attract more than a small percentage of University students. Excellent lectures are delivered by the professors to scanty audiences, and the great bulk of those educated at the University receive no more tincture of science than their predecessors did twenty years ago.

The recognition of science among the subjects of University examinations is by no means an unmixed advantage to those concerned. Examinations have played and will continue to play a useful part in directing and stimulating study, and in securing the distribution of rewards according to merit; but they produce in the student, as has often been pointed out, a habit of looking to success in examination as the end of his studies. This habit of mind is peculiarly alien to the true spirit of scientific work. Only such knowledge is valued as is likely to be producible at the appointed time. Whether a theory is consistent or true is immaterial, provided it is *probable*, that is to say, advanced by some author whose authority an examiner would recognise. All incidental observations and experimental inquiry lying outside the regular laboratory course, which are the natural beginnings of original work, must be eschewed as trespassing on the time needed for preparation. The examination comes; the University career is at an end; and the student departs, perhaps with a considerable knowledge of scientific facts and theories, but without having experienced the pleasure, still so easily gained in our young science of chemistry, of adding one new fact to the pile of knowledge, and, it may be, with little more inclination to engage in such pursuit than have most of his contemporaries to continue the study of Aristotle or Livy.

However, examinations have their strong side, to which I have referred, as well as their weak side; and although it is the natural desire of a teacher to see his more promising pupils contributing to the science with whose principles and methods they have laboured to become acquainted, the younger, like the elder branches of knowledge, must be content to serve as instruments for developing men's minds. Chemistry can only claim a place in general education if its study serves, not to make men chemists, but to help in making them intelligent and well-informed. If it is found to serve this purpose well, the number of chemical students at the Universities ought to increase; and if the number increases, no rigour of the examination system will prevent one or two, perhaps, in every year adopting chemistry as the pursuit of their lives. But the Universities have little power to determine what number of students shall follow any particular line of study. With certain reserves in favour of classics and mathematics, their system is that of free-trade. Young men of eighteen or nineteen have tastes already formed, some for the studies which were put before them at school, in which, perhaps, they are already proficient and have been already successful, some for games and good fellowship. It is, from the nature of the case, with the masters of schools that the responsibility rests of fixing the position of science in education. During the last ten years provision has been made at most of the larger schools for the teaching of some branches of science; and those who recall the conservatism of schoolboys, and their consequent prejudice in favour of the older studies, will understand a part of the difficulties which have had to be encountered. The main and insurmountable difficulty is what I may call the impenetrability of studies. A new subject cannot be brought in without displacing in part those to which the school-hours have been allotted. It is the same difficulty which occurs again and again in human life. There are so many things which it would be well to know and well to follow; but life, like school-time, is too short for all. From the educational phase of this difficulty the natural difference of tastes and aptitudes provides in some degree a way of escape. I think that wherever a school can afford appliances for the teaching of chemistry, all the boys should pass through the hands of the teacher of this subject. Two or three hours a week during one school-year would be sufficient to enable the teacher to judge what pupils were most promising. There may be instances to the contrary, but I no not think it likely that any boy who attended chemical lectures for a year without becoming interested in the subject would ever pursue it afterwards with success. Suppose that out of one hundred boys who have gone through this course, five are selected as having shown more intelligence or interest than the rest; they should be permitted to give a considerable part of their time, while still at school, to studying science without suffering loss of position in the school, or forfeiting the chance of scholarships or prizes. If any such system is possible and were generally adopted, each school sending annually to the Universities, or other institutions for the education of young men, its small contribution of scientific students, the professor's lecture-rooms and laboratories would be filled with young men who had already learnt the rudiments of science. Laboratories of research as well as of elementary instruction would find a place at the English Universities, and the reproach of barrenness would be rolled away.

Some of the defects or difficulties to which I have adverted are perhaps peculiar to our older schools and universities. The introduction of the study of natural science has borne earlier fruit in schools whose celebrity is of more recent date, such as the excellent college in this neighbourhood. Oxford and Cambridge ought to possess, but are far from possessing, such laboratories as have lately been built at the Owens College, Manchester. It is proposed to constitute in this city a College of Science and Literature, similar to Owens College and in connection with two of the Oxford colleges. The scheme set forth by its promoters appears thoroughly wise and well-considered, and all who are interested in scientific education must wish it success.

I have placed first among the modes in which science, and in particular chemical science, may be advanced, the assignment to it of a more prominent and honoured place in education; but owing, as I do, my own scientific calling and opportunities of work to a bequest made to Christ Church by Dr. Matthew Lee more than a hundred years ago, I cannot forget or disbelieve in the influence of endowments.

I have spoken of the leisurely class in this country as that to which scientific chemistry must look for its votaries. In our social conditions and in the absence of endowments it is hard to see where else they can be found. Men who have their livelihood to make cannot afford to spend money, and still less to bestow their time and energy, on the luxury of scientific inquiry. Even if they have the opportunity of earning their livelihood by scientific teaching, and with it the command of laboratory and apparatus, no leisure may remain to them for original work, and the impulse to such work (often, it must be admitted, of a feeble constitution) is starved in the midst of plenty. The application of endowments to the promotion of original research is a difficult question. I am inclined to think that posts, constituted chiefly with this object, should be attached in every case to some educational body, and should have light educational duties assigned to them. The multiplication of such posts in connection with the many colleges and schools in this country, where there is some small demand for chemical teaching, with the provision in each case of a sufficient laboratory and means of work, would probably do more than any centralised scheme for the promotion of chemical research.

To the advancement of chemistry by the formation of public opinion on the questions of scientific education and the endowment of original research, the Chemical Section of the British Association may reasonably hope to contribute. But doubts have been expressed as to the serviceableness of this or any such organisation for the direct advancement of our science itself. No doubt we cannot accomplish much. Chemical inquirers at the present time may be compared to a party of children picking wild flowers in a large field: at first all were near together, but as they advanced they separated, till now they are widely scattered, singly, or in groups, each busy upon some little spot, while for every flower that is gathered ten thousand others remain untouched.

That the science of chemistry would advance more rapidly if it were possible to organise chemists into working parties, having each a definite region to explore, cannot, I think, be doubted. Is such organisation in any degree possible?

The experiments of which Bacon has left a record, though curious historically, have no scientific value. But in one respect his "Physiological Remains" furnish an example which we might follow with profit. "Furthermore," he writes, "we propose *wishes* of such things as are hitherto only desired and not had, together with those things which border on them, for the exciting the industry of man's mind." I will quote further, as an example, a part of one of his "wishes," which has very recently been fulfilled. "Upon glass four things would be put in proof. The first, means to make the glass more crystalline. The second, to make it more strong for falls and for fire, though it come not to the degree to be malleable."

I do not know that the industry of M. de la Bastie's mind was excited by Bacon's mention of glass more strong for falls and for fire among things hitherto only desired and not had; but the conception of such an enumeration seems to me worthy of its author. Much fruitless and discouraging labour might be saved, a stimulus might be given to experimental inquiry, and chemical research might become more systematic and thus more productive, if Bacon's example were followed by the leaders of chemistry at the present day.

The Council of the Pharmaceutical Conference, whose meeting has just preceded our own, has published a list of subjects for research which they commend to the attention of chemists. Where one of these subjects has been undertaken by any chemist his name is appended to it. Might not the representatives of scientific chemistry issue a similar list?

Perhaps two or three of the distinguished English chemists who are members of this Association might be willing to serve on a committee which should put itself into communication with the leaders of chemical inquiry abroad, and should make and obtain and publish suggestions of subjects for research. Such a list so got together would, I think, find a welcome place in all scientific journals, and would thus be widely known and easily accessible to every student.

That which chiefly makes the organisation of chemical inquiry desirable is the boundless extent of the field upon which we have entered. Not every fact, however laboriously attained and rigorously proved, is an important fact, in chemistry any more than in other branches of knowledge. Our aim is to discover the laws which govern the transformations of matter; and we are occupied in amassing a vast collection of receipts for the preparation of different substances, and facts as to their composition and properties, which may be of no more service to the generalisations of the science, whenever our Newton arises, than were, I conceive, the bulk of the stars to the conception of gravitation.

It may, however, be urged that the growth of chemical theory keeps pace with the accumulation of chemical facts. It is so, if the elaboration of constitutional formulæ is leading us up to such a theory. But at present, however useful and ingenious this mode of summarising chemical facts may be, it does not amount to a theory of chemistry.

Two objections to regarding such formulæ as anything more than a chemical short-hand, as it has been termed, seem worth recalling. The first is mentioned at the outset in most text-books in which these formulæ are employed, but sometimes, I venture to think, lost sight of afterwards. The arrangement of the atoms of a molecule in one plane is equally convenient in diagrams, and improbable as a natural fact. But is not this arrangement used as though it were a natural fact when the possible number of isomeric bodies is inferred from the number of different groupings of the atoms which can be effected on a plane surface? The conceptions of plane geometry are much simpler than those of solid geometry (which is another recommendation of the present system of formulæ); but so far as I am able to follow the similar theories which have recently been propounded independently by MM. Le Bel and van't Hoff, the consideration of the possible isomerisms of *solid* molecules leads to new conclusions.[*] Wislicenus has found that paralactic acid undergoes the same transformations as ordinary lactic acid when heated and when oxidised. The two acids differ in their action on polarised light. His conclusion is that paralactic acid does not differ in its atomic structure from the lactic acid of fermentation, and that the kind of isomerism which exists between the two acids is not connected with the difference in the reciprocal arrangement of the atoms, but rather with a difference in the geometric structure of the molecule. To this difference he gives the name of "geometric isomerism."[†] The authors named above agree in supposing that the action of substances in solution on polarised light results from an unsymmetrical arrangement of atoms and radicles in three dimensions around a nucleus-atom of carbon.

The second objection relates to the statical character of the account which "developed" formulæ give of the differences between different kinds of matter. The modern theory of heat supposes, not only that the molecules which constitute any portion of matter are in constant rapid motion, but that the atoms which constitute each molecule are similarly moving to and fro. Such movement might be an oscillation about the position assigned to the several atoms in the constitutional formula of the molecule. Since, however, the modes of formation and decomposition of substances are the principal facts upon which the formulæ are based, it is to be considered whether these facts may not depend altogether upon the nature or average nature of the motion impressed upon the atoms—that is, upon dynamical and not upon statical differences.

Many substances are known whose existence is contrary to the theory of valency and saturation, such as nitric oxide and carbonic oxide; others, which transgress the theory of isomerism, such as chloride of dichlordibromethane ($C^2 Cl^2 Br^2, Cl^2$) and bromide of tetrachlorethane ($C^2 Cl^4, Br^2$), which should be identical, but are isomeric:[‡] yet these theories are simply an expression of the statement that certain substances can exist or can differ, while others cannot. It is true that in the vast majority of cases the theoretical limitation seems to hold good. But just as the absence of any fossil remains of the connecting links between species is only significant if the geologic search has been sufficiently thorough, so it is with chemical theories depending upon the non-existence of certain classes of bodies. Indeed, in our case, where investigation is guided by theory, and, as a rule, only those things which are looked for are found, the limitation may be partly of our own making. A chemist who should depart from the general course, and set himself to prepare substances whose existence is not indicated by theory, would perhaps obtain results of more than the usual interest.

Among chemical inquiries, if ever such a list as I have ventured to suggest should be drawn out, I hope that many would be included relating to the most familiar substances and the simplest cases of chemical change. The thorough study of a few reactions might perhaps bring in more knowledge of the laws of chemistry than the preparation of many new substances.

I believe that if any chemist not content with a process giving a good yield of some product examines minutely the nature of the reaction, observing its course as well as its final result, he will find much more for study than the chemical equation represents. He will probably also find that the reaction and its conditions are of a formidable complexity, and will be driven back towards the beginnings of chemistry for cases sufficiently simple for profitable study.

In concluding my remarks, I desire briefly to refer to another branch of chemical science, to the advancement of which this Association seeks to contribute, I mean applied or technical chemistry. One of the principal differences between the papers read before this Section, as a class, and those which the Chemical Society receives, is the larger proportion in our list of papers on technical subjects. Whatever chemists may hold, there can be no doubt that the estimation of our science by the outside world rests largely on the well-founded belief that chemistry is useful. Indeed, though scientific chemists are justly eager to vindicate the value of investigations remote from any application to the arts, they cannot feel a livelier sense of triumph when the successful synthesis of a vegetable principle yields at the same time a product of great technical value, as in the case of the production of artificial alizarin.

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[*] Bull. de la Soc. Chem. de Paris, t. xxii. p. 337, and t. xxiii. p. 295.

[†] Ann. Chim. et Phys., 5^{me} série, t. i. p. 122.

[‡] Bull. de la Soc. Chim. de Paris, t. xxiv. p. 197.

By visiting in turn the principal centres of British industry, this Association brings together men engaged on pure and on applied chemistry. We who come as visitors may hope that our papers and discussions here may bring fresh interest in the science, if not actual hints for practice, to those whose art or manufacture is based on chemistry. In return, the most interesting communications the Section has received have not unfrequently been the descriptions of local industries; and there is no part of our hospitable reception more welcome and more instructive to us than the opportunities which are provided of seeing chemical transformations on a large scale, effected by processes which observation and inventiveness have gradually brought to perfection and with the surprising familiarity and skill which are engendered by daily use.

SECTION D.—BIOLOGY.

Department of Zoology and Botany.

Dr. Hector, chief of the New Zealand Survey, gave a most interesting account of the modes of occurrence of the Moa bones in New Zealand. He used the term Moa in preference to that of Dinornis, because the bones of the New Zealand birds were now divided among so many genera. He demonstrated most conclusively that the knowledge of their former existence was not communicated to the Maoris by the Europeans, who deduced their structure from their remains, but, on the contrary, was imparted to the latter by the former. Up to recent times there had been a constant fulfilment of the statements made by the Maoris concerning the localities in which the bones would be found. He believed there was no hope of ever finding the birds alive, for he himself had been over the whole of the islands very thoroughly without seeing them. Dr. Hector exhibited a map of New Zealand on which were denoted all the areas in which Moa bones had been found, and all the localities in which considerable finds of bones had been made, with indications of their condition or surroundings. He found that the country occupied by primeval forests before the advent of Europeans was that in which Moa bones did *not* occur. His deduction was that they lived in the open and low scrub, in which they could walk. In all this region, within his own memory, the Moa bones were extremely abundant in the South Island, all over the ground; but these bones were very rarely found in collections, for they were usually decomposed and split and warped. In the enormous extent of Sub-Alpine country in the South Island, which was covered by only a light vegetation, large quantities of well-preserved Moa remains had been recently found, associated with remains or reliques of natives. It appeared to him that the natives had pressed up the country for the purpose of capturing, killing, and eating the Moas; and as the natives could not follow them through the sharp bayonet-grass and other underscrub, they seemed to have got at them by setting portions of it on fire, which collected the animals together, often killed them, and accounted for so many of their bones being accumulated in particular spots. And in some of these localities where the Moas were destroyed by fire, little heaps of chalcedonic quartz pebbles, which were their crop-stones, were found, each heap associated with the remains of one bird. And this fact, of their being the crop-stones, had been conclusively proved by the discovery of a carcase crushed and decayed so as to be unfit for anatomical purposes, but containing within the thorax just such a little heap of pebbles as had been described. The second chief mode of occurrence of Moa bones was in the turbary deposits and desiccated swamps, occurring in almost all the valleys leading to the east coast. One notable deposit was at Glenmark, where the remains of a terrace at a higher level had been cut through by the stream, leaving a large turbary deposit on the shoulders of the hill on both sides. Here were found a great number of Moa bones, without any associated Maori implements. Out of this place had been got bones sufficient to cover twice the area of the Section Room. They occurred mixed together, and above, below, and among great accumulations of drift-wood, which were ten or twelve feet deep over many acres. The bones got out of that deposit indicated at least 1,700 individuals, which had either been carried down and smothered in floods or which had died naturally and been carried down by the water. Similar deposits occurred in caves, and in turbary deposits on the coast, which were exposed below high-water mark, showing that there had been comparatively modern submersion; but there were no marine deposits above, and they rested on a denuded surface of the latest Tertiary beds. There seemed to have been an uninterrupted submergence of New Zealand since the time when the Moas were first developed in such large numbers; and there had been no considerable re-emergence of the land since then. Another mode of occurrence of Moa bones was wherever the country was favourable for Maori camps, on the sheltered grassy plots and links, or among the sand-hills near. They were associated with their cooking-hollows, and with stone implements, which, however Neolithic in aspect, were similar to those used now by Maoris. It had been said that the oldest Moa remains were those associated with the ancient moraines of the upper valleys, but these were the great natural roads up which it was very likely that some Moas would travel and leave their remains there. In caves the Moa bones were found resting on the stalactitic shelves, perhaps cemented by a little carbonate of lime. They were hardly ever found on the lower surfaces of the caves; and he believed they had mostly gained access to the caves by falling through the upper chasms. He had evidence that sheep in modern days fell through in the same way, and their bones were found similarly situated in the caves. The earliest traces of the Moas that had been found were footprints at Poverty Bay, occurring in a soft pumice sandstone, within six or eight inches of the upper surface. Many blocks had been procured with these undoubted footprints. The lower surface of each depression was formed of very fine micaceous sand, but it was filled up with much coarser green quartzose sand. After the birds had passed, the impression had been filled up by blown sand. Undoubtedly a true bird-bone had been found in Tertiary deposits in New Zealand, but he was inclined to think it belonged to a gigantic extinct Penguin.—The President testified to the value ot Dr. Hector's address by saying that he had never till that time really understood the modes of occurrence of Moa bones.—Prof. W. C. Williamson said that scientific workers who had advice and sympathy readily accessible to them could know little of the energy and enthusiasm required to sustain the solitary individual who had to labour without meeting a scientific or even an educated man for weeks and months. Dr. Hector was a conspicuous example in this respect, and deserved all the honour his fellow-workers in England could give him.

Dr. Carpenter gave a summary of the results of his investigations into the nervous and generative systems of comatula. He described as a nervous cord the cord existing in the axial hole of the skeletal segments, which Müller had described as a vessel. No cavity was to be found in it, and in a favourable plane of section branches from it to the tentacular muscles were detected. Although this cord was destitute of the ordinary structure and insulating material of nerves, that was explicable by the fact that only one kind of muscle had to be affected, and that all the muscles acted simultaneously, in flexion of the arm. The cord to each arm came off from the curious five-lobed organ in the calyx below the perivisceral cavity. This was determined to be the central nervous mass by the following experiment. A living comatula was taken, and the visceral mass was turned out. A needle was thrust into the supposed nervous organ, and instantly all the arms were coiled up to their full extent, and were gradually relaxed. This was repeated several times. A curious generative axis had also been discovered in the shape of a cord passing through the middle of the nervous centre, and through the visceral mass to spread into a plexus around the mouth. Thence branches were given off to the arms and pinnules, and the ovaries and testes were directly connected with these cords as axes. Dr. Carpenter said that these facts were such as to necessitate the separation of the crinoids much further from the rest of the echinoderms than hitherto. In fact, he considered they had little in common beyond the calcareous network of the skeleton. In conclusion he said that he had learnt from a trustworthy observer that after a recent hurricane in the West Indies a vast number of Pentacrini had strewed the shore of Barbadoes, in all stages of growth, from one inch to eighteen inches in length; but unfortunately no naturalist was at hand to reap the rich harvest.

Dr. I. Bayley Balfour read a paper *On the Flora and Geological Structure of the Mascarene Islands.* He said that in Bourbon there was a great contrast between the flora of the older north-western portion and that of the south-eastern district within the area formed by the volcano now acting. Here the soil was very barren, with only a few composites and other plants that flourished in a dry soil. The flora was not most closely allied to that of Africa, but rather to that of India and the Indian Archipelago.

There was a great profusion of ferns, mosses, and lower cryptogams; and evergreens were abundant. The species were few in proportion to the genera, and the genera in proportion to the orders. The proportion of indigenous plants and of species to any area was generally small; but in Bourbon there was the great number of 1,700 species. The most remarkable genus in the group, perhaps, was Pandanus, the screw-pine, which had species peculiar to each island, though the commonest, *P. utilis*, occurred on all three islands. Certain genera were found to be endemic to the group, especially in the Rubiaceæ and Compositæ. In addition, in each island there were certain genera endemic to that island alone. In North-western Bourbon, although, as in Mauritius, settlers had produced much alteration by cutting down trees, &c., there was still an abundance of plants which flourished in a moist climate. The flora of Mauritius exhibited affinities with that of N. W. Bourbon, although possessing endemic genera. Perhaps no place in the world had had its flora so much altered by settlers, especially by means of fires through carelessness. The original flora had been almost exterminated. The few plants now remaining included one new genus; and there were certain peculiar Pandani, but the general type was allied to that of Mauritius. In many of the small volcanic and coral islands which surround Mauritius and Rodriguez, very often little more than rocks, there were genera which were peculiar to those islands, or else species that were representatives of other species existing on the main islands. Round Island, a mere cone near Mauritius, had three genera of palms represented by different species, which were found nowhere else; and exhibited many other peculiarities in its flora. Dr. Balfour reserved his opinion on the vexed question of the origin of these islands by independent volcanic action or by the submergence of an ancient continent connected with Africa; but stated that soundings taken between Mauritius and Rodriguez, about fifty miles west from the latter, gave a depth of 2,000 fathoms; while 100 miles S.W. of Mauritius the depth was 2,700 fathoms.—Prof. Williamson remarked on the parallel between these facts and those first brought to light by Mr. Darwin relative to Galapagos. It appeared that these modifications of species and genera were such as must necessarily have resulted from modifications in a long course of time; and they compelled naturalists to accept Mr. Darwin's views whether they liked them or not. Coupled with the facts derived by Mr. Wallace from the Indian Archipelago, he thought considerable probability was given to the submergence theory.—Prof. Dickson could not see that the occurrence of representative forms on different oceanic islands was any stronger proof of evolution than the facts relating to the grouping of plants about geographical centres; but Prof. Williamson maintained that the occurrence of distinct yet analogous species on contiguous islands of very recent geological age was a striking evidence of modification produced by new physical conditions, unless indeed distinct new creative acts were admitted within a comparatively modern period.

Prof. Williamson gave an account of his recent discoveries among the fossil seeds of the coal measures, and partly confirmed and partly controverted Brogniart's views on some of the same seeds. He (Prof. Williamson) gave the name Lagenostoma to a form of seed larger and more bulky than a grain of rice, which had a flask-shaped cavity above the nucleus, between it and the micropyle. This cavity was surrounded by a membrane quite distinct from that investing the nucleus. Prof. Williamson believed that he had found pollen grains in this cavity, and that the only difference between this and an ordinary coniferous seed consisted in the presence of this chamber, which protected the pollen and brought it into contact with the nucleus. Another seed of the same general type had the upper part of the nucleus contracted, forming a sort of mammilla: thus the cavity above became of a different shape. He named it Physostoma. Another type he called Æthiotesta. All these were from the Lancashire coal-field. A specimen from Burntisland showed a transition from the extremely small and narrow micropyle of ordinary angiospermous seeds, and the large chamber of Lagenostoma. Prof. Williamson also referred to Cardiocarpum, which he found to have the nucleus thickened, and to have a prolonged spur containing the micropyle. Antholithes and Cardiocarpum were but portions of the same flowering plant. He found that Trigonocarpum had really a long projection at the end, of a similar nature, but from some Newcastle specimens he inferred that it had a large investing sarcocarp. The type was not at all dissimilar to Cardiocarpum.

Prof. Balfour, in a *Notice of Rare Plants from Scotland*, drew attention to the discovery of *Naias flexilis* in Perthshire, hitherto only found in Ireland. He exhibited the original specimen of *Salix sadleri* and *Carex frigida*, discovered in Scotland last year by Mr. Sadler.—Dr. I. Bayley Balfour contributed some notes on Turneriaceæ from Rodriguez, especially referring to one new form.—Prof. A. Dickson exhibited a *Primula vulgaris* with interpetaline lobes, and pointed out its relations to Soldenella and other Primulaceæ; he also described a monstrosity in *Saxifraga stellaris*, in which there occurred a calyx, no corolla, many stamens, and many carpels. Two specimens were found, each with a single terminal monstrous flower.

It is to be regretted that there was a paucity in the attendance of distinguished zoologists and botanists, and that the number and importance of the papers read was not so great as to furnish any idea of a widespread existence or encouragement of research in natural history. It might be well for naturalists to put themselves in evidence a little more strongly, and to show the value of their results more prominently, if they desire to be aided in their researches by public funds, or to win general sympathy, especially when geologists and anthropologists make such vigorous displays of their conquests.

Department of Anatomy and Physiology.

Prof. Rolleston, in moving a vote of thanks to Prof. Cleland for his presidential address to the department, said he had rarely spent an hour with more pleasure than in listening to that address. He would show the value he set upon it by saying that Prof. Cleland's old master, the great John Goodsir, would have been glad to hear it. He believed much of what the President had said would take its date from that meeting as of permanent authority and value.

Dr. McKendrick read the important report *On the Physiological Action of Light*, by himself and Prof. Dewar. We hope to publish it in full in an early number.

Mr. W. J. Cooper, in a paper *On the Physiological Effects of various Drinking Waters*, referred to the experiments of M. Papillon on various animals, described before the French Academy of Science in 1870–73, by which it was shown that not only the ash of the food eaten affects the composition of the bones, but also that mineral matter in dilute solution is capable of being assimilated. Consequently, alterations in the composition of the water supply of a community might be of very great importance to the organic structure of the human body, if the very composition of the bones is affected by the quality of the water. The inorganic impurities of water had been too much overlooked, notwithstanding the serious consequences which sometimes follow. Mr. Cooper insisted that one of the first conditions in the inauguration of a water-supply should be to ensure perfect freedom from excess of any mineral except those comparatively harmless ingredients, chloride of sodium and carbonate of lime.

Mr. T. G. P. Hallett read a paper *On the Conservation of Forces*, devoted to a long argument against this principle being extended to vital phenomena. He endeavoured to prove that life, whether tested by its origin or its effects, was a force, and that the laws of that force were not such as the conservation principle required and declared. Dr. Allen Thomson, at the close of the discussion which followed, thought it best to suspend judgment on the points that had been mooted, and to continue the quiet investigation of physical phenomena; his impression, derived from long observation, being that the more the phenomena of life were attended to, the more fully they were explained by known laws.

Among other papers may be mentioned Messrs. L. C. Miall and F. Greenwood's, *On Vascular Plexuses in the Elephant and some other Animals*, and Mr. Greenwood's *On the Preservation of the Larger Animals for Anatomical Examination.*

If the papers read before the Department of Anatomy and Physiology had to be taken as an index of the activity of research and thought concerning these subjects in Great Britain, we should have to confess ourselves to be at a low ebb. The department only sat on three days out of five, and those three days were certainly not crowded with valuable papers. The physiological investigations of Drs. McKendrick, Lauder Brunton, and Pye-Smith, and Prof. Dewar, were of high interest and great value; but the subjects they referred to cover only a very small part of the wide domain of Physiology. Morphology was represented most worthily by the President's address, but there was a plentiful lack of memoirs on descriptive anatomy, morphology, embryology, and histology. It is of course difficult to make the details of morphological investigation interesting in a spoken narration, but expositions of new or improved principles, and results of research in all departments, could be usefully brought forward at these meetings and receive illumination from discussion by those in authority. Are our anatomists and physiologists less willing to make such efforts than other scientific men, or have they a greater fondness for remaining in their own special haunts without emerging on any common ground?

Department of Anthropology.

Miss A. W. Buckland, of Bath, read a paper *On Rhabdomancy and Belomancy*, in which she endeavoured to show that rhabdomancy, or divination by means of a rod, still practised in England in some localities, was a survival of a very ancient superstition, originating in the use of rods as symbols of power.

Mr. John Evans described fully the proposed code of symbols for archæological maps which has been drawn up by a committee of leading archæologists on the continent of Europe, and will probably be extensively used. Suggestive crude symbols are adopted for the leading varieties of ancient remains, and a series of modifications of each chief form is to be used, to denote as far as possible the exact nature of the remains.

Mr. Hyde Clarke furnished a notice of the prehistoric names of weapons, in continuation of a note laid before the British Association in 1873, which showed that there was a community of aboriginal names of weapons in the prehistoric epoch. He now added that further research had confirmed these views.

Mr. Hyde Clarke also read a paper *On Prehistoric Culture in India and Africa.* After referring to his investigations as to the evidence of the successive migration and distribution of languages in Asia, Africa, North, Central, and South America, and in some cases in Australia, he proceeded to give the result of later special investigations as to the community of culture in India and Africa. The philology of the aboriginal languages of India could only be effectually studied from those of Africa, and Mr. Hyde Clarke suggested that it would be a great advantage if some of the missionaries of the two regions could interchange stations.—Prof. Rolleston remarked upon the desirableness of a complete work being prepared on the present ethnology of India, under the superintendence and at the cost of the Indian Government.

Dr. Phené, in his paper *On the Works, Manners, and Customs of the Prehistoric Inhabitants of the Mendip Hills*, adopted the theory of a similarity of race in the people who formerly occupied the caves on the Atlantic seaboard of Europe and of Britain; and identified the inhabitants of the Mendips with them.

Mr. D. Mackintosh read a paper *On Anthropology, Sociology, and Nationality*, which referred especially to distinctions of race in the British Isles, and defended his previously expressed views. He believed that the various colonising tribes had either continued in certain localities with little interblending, or that the process of amalgamation had not been sufficient to prevent the persistence of the more hardened characteristics. He tried to show that between the north-east and south-west the difference in the character of the people, irrespectively of circumstances, is so great as to give a semi-nationality to each division—restless activity, ambition, and commercial speculation predominating in the north-east, and contentment and leisurely reflection in the south-west.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—DETROIT MEETING.

LAST week we gave a general account of the meeting of the American Association, from an American correspondent. The following are brief notices of some of the principal papers read.

We have already referred to the presidential address of Prof. Le Conte, and to the address of Prof. Dawson, both of which were anti-evolutionary, the latter more distinctly so than the former. Prof. Dawson's views are so well known that we need not refer at length to his Association address.

Prof. Augustus R. Grote, Director of the Museum of the Buffalo Academy of Sciences, undertook the task of throwing light upon past geological eras by showing the present distribution of certain North American insects. He described the glacial epoch as occurring at the close of the Tertiary by a continuous loss of heat. The winters gradually lengthened, the summers shortened. The tops of mountains that now bear foliage were then covered with snow, which, in time consolidating, formed glacial ice that flowed into the valleys. Gradually an icy sea extending from the north spread southward, even over the Southern States and down the Valley of the Mississippi. Existing insects of the Pliocene, no matter how gradually they were affected by the change, must have eventually left their haunts, and doubtless many species were exterminated. At the present day there are found in the tops of the White Mountains, and in the lofty ranges of Colorado, certain species of butterflies and moths which are completely isolated. To find others of the same kinds we must explore the Plains of Labrador and the northern portions of our continent; there and there only do we find similar or analogous species. A White Mountain butterfly, *Oeneis Semidea*, was cited as an instance in point, and other butterflies and moths were mentioned, whose isolated habitats served to prove the general proposition. The retirement of the glacial seas at the close of the epoch was then considered. Then the summers were lengthening, while the winters were shortened. Then ice-loving insects, such as the White Mountain butterfly, hung on the edge of the ice sheet which supplied their food, and followed its retreat—not all, but some of their forms surviving. Straying upon the local glaciers of the mountain ranges, they were left behind in some instances, while the main body followed the retiring ice sheet to the far north. Those that were left behind still find the conditions of their existence in the snow-covered summits of the present day. As the valleys became warmer and glaciers fewer, the chances of their escape from their isolated positions gradually diminished till their removal became impossible.

Prof. E. S. Morse, of Salem, Mass., has for a long time made a study of the bones of embryo birds. At this meeting he recalled briefly the evidence he had shown last year regarding the existence of the intermedium in birds by citing the embryo tern, in which he had distinctly found it. This year he made a visit to Grand Menan expressly to study the embryology of the lower birds, and was fortunate in finding the occurrence of this bone in the petrel, sea-pigeon, and eider duck. This additional evidence showed beyond question the existence of four tarsal bones in birds, as well as four carpal ones. In these investigations he had also discovered embryo claws on two of the fingers of the wing—the index and middle finger. Heretofore in the adult bird a single claw only had occurred in a few species, such as the Syrian blackbird, spur-winged goose, knob-winged dove, jacana, mound bird, and a few others, and in these cases it occurred either on the index or middle finger or on the radial side of the metacarpus. All these facts lent additional proof of the reptilian affinities of birds.

Prof. S. P. Langley, of Alleghany Observatory, detailed some of the conclusions at which he had arrived after years of study of the solar surface. Prof. Langley first showed by comparative experiments that an absorptive atmosphere surrounds the sun. Little attention has in recent years been paid to the study of this atmosphere. The earlier efforts to tabulate its absorptive power, produced with different observers, though men of eminence, strangely discordant results. Their methods and deductions were given in detail. Secchi's results, making the neighbourhood of the edge of the sun about half the brightness of the centre, are probably near the fact. Prof. Langley applied well-known photometric methods to the problem. By attaching a circle of cardboard to the equatorial telescope, a solar image is received on the board, plainly showing spots, penumbræ, &c., if the image be one foot in diameter. From holes in this cardboard, pencils of rays issue, which being caught on a screen give a second series of images. If these images are caught upon separate mirrors, instead of a screen, their relative light can be made the subject of comparison with that of a disc of flame from Bunsen's apparatus, and thereby their relative intensity determined. Between each aperture and its respective mirror a lens was interposed which concentrated the pencil of rays. By suitable additions this apparatus can be converted to a Rumford photometer, and in this form it proved most available in Prof. Langley's hands. He found a value for the brilliancy of the umbra in sun-spots, considerably higher than that hitherto computed. The blackest umbra, he finds, is betweeen 5,000 and 10,000 times as bright as the full moon. The light of the sun is absorbed by its atmosphere not in the same, but in a greater proportion than its heat. A long series of experiments shows that not much more or less than one-half of the radiant heat of the sun is absorbed or suffers internal reflection by the atmosphere of the sun itself. Observations indicate that this atmosphere is (speaking comparatively) extremely thin; Prof. Langley is inclined to regard it as identical with the "reversing layer" observed by Dr. Young, of Dartmouth, at the base of the chromosphere, though the chromospheric shadow should perhaps be taken into the account. The importance of a study of this absorbent atmosphere becomes evident if we admit that the greater part of the 500° which separate the temperature of the temperate zone from absolute zero is principally due to the sun's radiation. To this atmosphere new matter is constantly being added and taken away by the continual changes of the interior surface. Any alteration in the capacity for absorption—say a difference of 25 per cent., which could hardly be recognised by observation—would alter the temperature of our globe by 100°. The existence of life on the earth is clearly dependent on the constancy of the depth and absorption of this solar envelope. Hitherto we have chiefly confined calculations to the diminution of solar heat by contraction of the sun's mass—an operation likely to go on with great uniformity. But here is an element of far more rapid variation. If changes in the depth of this solar envelope are cyclical, they would be accompanied by cyclical alterations of earth's temperature. This may serve alike to explain the characteristics of variable stars and the vast secular changes on earth indicated by geology. If the law of alterations in that envelope can be ascertained, new light may be shed on the history of the globe and the near future of life upon it.

Prof. Thomas Meehan, of Germantown, Penn., made an attack on Darwinian theories in a paper which disputed the assumption that insects are a material aid in the fertilisation of plants. He drew the following conclusions: (1) That the great bulk of coloured flowering plants are self-fertilisers. (2) That only to a limited extent do insects aid fertilisation. (3) Self-fertilisers are in every way as healthy and vigorous, and are immensely more productive, than those dependent on insect aid. (4) That when plants are so dependent they are the worse fitted to engage in the struggle for life—the great underlying principle in natural selection.

Prof. Morse described the evident characteristics of insects which seemed not only fitted for fertilisation, but were found actually engaged in the process. He was not prepared to abandon the vast mass of facts already obtained on account of the few and doubtful experiments detailed by Prof. Meehan. Prof. Riley thought that the fact that insects were absolutely essential to the existence and perpetuation of many plants, had been proved by experiments and observations so numerous and convincing that it could no longer be denied. He mentioned his own experiments with the *Yucca;* and he met and combated the theory that self-fertilisation, like interbreeding, did not tend to deterioration. Prof. Meehan, in explanation of his views, stated that he regarded the present dependence of plants upon insects as an evidence of weakness and accident, or of deformation in the plant. Prof. Riley said that it was a mistake to suppose that insect life was scarce in the Rocky Mountains.

A paper was presented *On some New Fossil Fishes and their Zoological Relations,* by Prof. J. S. Newberry, of Columbia College, giving brief descriptions of interesting fish remains found during the past year in the Devonian and Carboniferous rocks of Ohio. Of these, the most important "find" was that of nearly the entire bony structure of a single individual of *Dinichthys Terrellii,* the hugest of all the old armour-plated Ganoids. Life-size drawings of most of these bones were exhibited to the Association, and copies of them will appear in the second volume of the "Geology of Ohio," now going through the press. Drawings of another species of *Dinichthys* was shown (*D. Hertzeri*) in which the maxillaries and mandibles are set with teeth instead of being sharp-edged. The remains of both these monsters have been found only in the upper Devonian rocks of Ohio. Prof. Newberry also exhibited to the Association teeth of *Dipterus Glenodus,* and those of a new genus belonging to the same family.

Prof. E. D. Cope, of Philadelphia, made a communication *On the Indications of Descent exhibited by North American Tertiary Mammalia.* The gradual development from one form to another by changes in the foot bones was traced through a long series from extinct Tertiary animals to those of the present day. A similar process of change was traced in the teeth of animals, the simpler forms of teeth in the Eocene being a crown with four tubercles. The human skeleton, Prof. Cope declared, retained many more ancient types than other Mammalia.

A paper from Prof. Daniel Kirkwood, of Bloomington, Ind., *On the Distribution of the Asteroids,* was read by Prof. Langley. Prof. Kirkwood stated that twenty years ago, when the number of known asteroids did not exceed fifty, it was inferred from purely physical considerations that there must be great irregularity in their distribution, and that gaps would be found in their zone where their periods were commensurable with those of the planet Jupiter. In 1866, when the number of asteroids amounted to eighty-eight, the agreement of theory and observation in this matter was the subject of a paper from Prof. Kirkwood, read at the Buffalo meeting of the Association, and the evidence was again summed up in a paper at Indianapolis in 1871. Since then thirty-one asteroids have been added to the group. It is now proposed to show that the truth of the theory advanced in 1866 is now more than ever determined. The Professor proceeds to divide the space between the asteroids into six zones by orbits whose periods would be commensurate with those of Jupiter. Then taking the members of the group in the order of their mean distances, it is found that the widest intervals between them are at these gaps where orbits would coincide with certain multiples of Jupiter's revolution. He remarks that it is a notable fact in the development of the solar system that the largest planet, Jupiter, should be succeeded by a space so nearly destitute of matter as the zone of the asteroids, the ratio of masses being as 1 to 5180. An explanation of the disproportion was given in a paper read in 1870; but it may be asked what might have been the result if the density of the asteroidal group had been equal to that of the other planetary rings. For reasons which he assigns, Prof. Kirkwood believes that if the asteroidal group had possessed a total density half that of Jupiter, they would when nebulous have been brought so closely into contact by the great planet's attraction as to fuse into one, instead of remaining as separate bodies. A similar result he regards as having taken place in the case of Uranus. A formation of the same kind would result where the period of a planet was one-third that of Jupiter; corresponding to the ratio between the periods of Jupiter and Saturn. The rare instances of great inclination among asteroids' orbits he is inclined to believe may have been occasioned by comets, when the minor planets were themselves in a cometary or nebulous condition.

The Hon. L. H. Morgan, of Rochester, read papers *On Ethnical Periods and the Arts of Subsistence.* The discussion of ethnology would be much facilitated by the use of a certain number of ethnical periods representing conditions in the advance of man from his earliest to his higher conditions. Mr. Morgan proposes the following:—

1. A period of savagery.
2. The opening period or lower status of barbarism.
3. The middle period of barbarism.
4. The closing or upper period of barbarism.
5. The period of civilisation.

The ages of stone, bronze, and iron have served a useful purpose in archæology, but the progress of knowledge has rendered more definite subdivisions necessary. The use of stone implements began far back in savagery, which extended even to the introduction of tools of iron. The successive arts of subsistence offer distinctions of more value. The period of savagery begins with the human race. The invention or practice of the art of pottery may enable us to draw the line between savagery and barbarism.

The transition from the lower to the middle stages of barbarism is marked in the eastern hemisphere by the domestication of animals; in the western by the cultivation of maize and succulent plants by irrigation, together with the use of adobe and stone in house architecture. The upper status of barbarism is cut off from civilisation by the invention and use in the latter of a phonetic alphabet and the art of writing.

In respect to the effect of arts of subsistence in modifying the improvement of mankind, Mr. Morgan takes very broad views. He is of the opinion that success in multiplying the sources and amount of food decided the question of man's supremacy on earth. His advance has been identified with improvement in this particular.

Prof. Burt G. Wilder, of Cornell University, read papers on the following natural history subjects:—Notes on the American Ganoids (*Amia, Lepidosteus, Acipenser,* and *Polyodon*); The Use and Morphological Significance of the Caudal Filament of the young *Lepidosteus*; The Embryology of Bats; The Affinities and Ancestry of the existing Sirenia. This paper was based upon three specimens which were exhibited. First, a fœtal Dugong, 2½ feet long, obtained from Australia through Prof. H. A. Ward. Second, a fœtal Manatee, between three and four inches long (as if extended), obtained from South America through Prof. James Orton. Third, a fœtal Cetacean (probably

Porpoise), three inches long (as if extended), lent to Prof. Wilder by Mr. Alex. Agassiz, Curator of the Museum of Comp. Zoology at Cambridge. The last two specimens are believed to be the smallest of their kind hitherto recorded.

Prof. Wm. S. Barnard, of Canton, Ill., read a paper *On the Development of the Opossum, Didelphys virginiana.*—Prof. Barnard read another paper, in which he compared the muscles of man with those of the higher apes, showing the points of similarity as well as of difference. An interesting point made in this paper was the statement that one of the buttock muscles supposed to be peculiar to the higher apes, distinguishing them from man, really existed in the human body and in a similar position. It was shown that the muscle thus described by Traill, and afterwards by Wilder as in the chimpanzee, and by Owen and Bischoff as in the orang, and by Coues as in the opossum, is also found in man, and offers no distinction in this respect. Three new muscles about the hip-joint, found in the orang and some other apes, were also made the subject of description; these muscles have no homologues in man. Two of these act to rotate the leg and draw it inward; the other seems too small to have any functional value and is probably a rudiment, but is interesting as occurring also in some of the lower apes and the opossum. The other muscles in this region of the body were like those of man, but in the case of an orang the short head of the biceps of the thigh was found entirely separated. This is only occasionally the case with the orang, and this peculiarity is not known to exist in any other animal. The two large external muscles of the calf do not unite with each other to form a single tendon Achillis, consequently in the orang this tendon is double, which sometimes occurs with marsupials. These investigations, which were explained in much technical detail, tend to prove that all the muscles possessed by man can be traced backward in the lower forms of animals, through the apes to the lemuroids.

Prof. Barnard gave a detailed account of his observations on the *Protozoa*, made in the anatomical laboratory of Cornell University, Ithaca, N.Y., where the specimens described were also seen by Prof. Wilder and others than the investigator himself.

Prof. George F. Barker, of Philadelphia, read a paper *On the Cause of the Relative Intensity of the Broken Lines of Metallic Spectra.* The purpose of this paper is to give the general result of a series of measurements made to ascertain, by Vierordt's method, the relative intensity of these various lines, and to compare these with their lengths measured micrometrically. Vierordt's method consists in measuring the intensity of a coloured light by the amount of white light necessary to extinguish it. By means of a third telescope attached to the spectroscope, a bright slit of light may be thrown upon any portion of the spectrum, and by varying the distance of the source of this light, until it extinguished the various spectrum lines in the order of their brightness, a series of numbers was obtained which, by the law of the inverse squares, gave the relative intensity of the different spectrum lines. The metals experimented upon were copper, gold, silver, antimony, bismuth, and magnesium. The general result is, that in no case does the length of the spectrum line follow the law of brightness. Hence some other hypothesis must be suggested to account for the phenomena. The author suggested one which seemed to him to be at least possible, and to be sustained by the prevalent views on molecular and atomic physics. The constitution of a gas is simple; the molecules composing it move in straight lines, and encounter each other and the walls of the containing vessel in so complex a way that Prof. Maxwell doubts if mathematics can follow their paths. The oscillations of the atoms within the molecule, are, however, less complex; they either are simple harmonic motions themselves, or they may be resolved into such. It is these harmonic vibrations which, communicated to the ether, cause the spectrum lines; the number of the different forms of oscillation constituting the number of lines in the spectrum, the period of any one oscillation determining the wave length of the corresponding line, and the amplitude fixing the brilliancy of that line. These things being granted, we have only to suppose what is perfectly conceivable, that the amplitude of the vibration, the only point we are now concerned with, varies with the temperature differently for each of the different kinds of vibration in the molecule, or, what is the same thing, with the wave length. If, for example, the peculiar harmonic vibration of the atoms of a copper molecule which gave the longest line in the green, diminished the amplitude of its oscillation less rapidly than the one in the blue, then this is a sufficient reason why it should be the longest. We may, therefore, by inspection of a broken spectrum, conclude at once on the rapidity with which the amplitude of the different harmonic vibrations of the atoms within the molecule decreases with decreasing temperatures, this being simply in the order in which the lines are arranged as to their length. This is offered as a working hypothesis to be proved or disproved by special investigation. From the facts already known it may be regarded as antecedently probable. It seems to be a step taken into the great field lying between chemistry and physics, at present a great and unexplored gulf. Work done here cannot be thrown away even if done to test an untenable hypothesis. It must bear fruit, though it may, be very different in kind from that anticipated.

REPORT ON THE PROGRESS AND CONDITION OF THE ROYAL GARDENS AT KEW DURING THE YEAR 1874

FROM Dr. Hooker's recently issued report on the progress and condition of the Royal Gardens, Kew, for 1874, we learn that a series of lectures, or, as they are called in the report, "practical lessons," have been given to the gardeners during the evenings, after working hours. These "lessons" embrace the elements of structural, systematic, and physiological botany; of chemistry, physical geography, and meteorology, in their application to horticulture; of economic botany, forestry, &c. They are given, some in the young men's Library, others in the Garden or Museum. Notes of these lessons have to be taken by those attending them, which, after being fairly written out in notebooks, are examined periodically by the teacher and corrected, or more explicit instruction given if necessary. The attendance at these lessons is voluntary, but the fact of "good attendance" is recorded in every gardener's certificate of conduct and proficiency on his leaving the service of the establishment.

These lessons have been instituted with the view of the better education of the gardeners in subjects bearing upon their profession, so as to qualify them for "Government and other situations in the Colonies and India, where a scientific knowledge of gardening, arboriculture, &c-, is required." Most of the colonial gardens and Government plantations are at the present time under the superintendence of able men, who received at some time or another instruction at Kew.

The liability of *Coffea arabica* to the attack of both insects and fungi have been abundantly proved of late by the visitation of the so-called blights in Dominica, Southern India, and more recently in Ceylon. In consequence of this a good deal of interest is attached to the prosperity of the Liberian Coffee, which has been distributed from Kew. On this subject Dr. Hooker says: "A large stock of true Liberian Coffee has been obtained through the kind efforts of Messrs. Irvine and Woodward, of Liverpool. This is a larger and perhaps different variety from that received from Cape Coast. . . . Large quantities of both have been sent to the coffee-growing British possessions, and have arrived in excellent condition. Dr. Thwaites states that the Cape Coast Coffee, the safe arrival of which in Ceylon I mentioned in the report of last year, is, notwithstanding that it was immediately attacked by the leaf disease, doing well. He also remarks that 'the Cape Coast and Liberian Coffees, although they would seem to differ much as regards size of their respective seeds, yet in the matter of foliage there is great resemblance between them. In this latter respect they differ considerably from the ordinary coffee plant of Ceylon, their leaves being a good deal larger, more firm in texture, and tapering more gradually to the base.'"

The increased cultivation of coffee, and the introduction of varieties better suited to resist the attacks of disease, has, it appears, attracted the attention not only of the British Government, but also of the Colonial Governments, so that a good deal of correspondence has arisen with Kew on the subject. Dr. Hooker says: "My attention has in consequence been directed (1) to obtaining accurate reports as to the nature of the disease, of which several are confounded under one common epithet; (2) to recommending measures for the cultivation of coffee in colonies once famous for its production where it has been almost abandoned, as well as in others where the cultivation has been scarcely attempted; and (3) to the cultivation of new and improved varieties."

The Blue Gum Tree (*Eucalyptus globulus*), which has now become so popular that plants some twelve or fourteen feet high may be seen growing in the open air in some of our London parks, is recommended for planting by Dr. Hooker, simply on account of its quick growth and its value as a timber tree, the wood being exceedingly hard and durable. With regard to its supposed beneficial effects in malarious districts, Dr. Hooker says he is "still unable to endorse the views of those who regard the tree as capable of cultivation in tropical swamps and as a prophylactic against ague and fever."

The prospects of the Ipecacuanha cultivation in India is, we are told, not very encouraging, owing rather to the slow growth and small yield of the underground root stock from which the drug is obtained, than to the want of success in growing and propagating the plants. "Nevertheless the cultivation must be persevered in. The causes that retard the progress of this valuable herb under cultivation are those that raise the price of it in its native country. Were it a plant that increased rapidly, it would be with difficulty eradicated from the forests which it inhabits."

One very important matter mentioned in the report is that referring to the new Herbarium, the site for which is not yet, however, determined upon. It is, moreover, satisfactory to learn that when erected it will, through the liberality of Thomas Philip Jodrell, Esq., M.A., the founder of the Jodrell Professorship (of Physiology) in University College, London, be associated with a laboratory for physiological botany. The contributions to the Gardens of living plants and seeds, to the Herbarium of dried plants, and to the museums of economic specimens, have been exceedingly numerous and interesting.

NOTES

M. JANSSEN's appointment as the head of a new French Physical Observatory, which we intimated some time ago, has been gazetted. The French Government, we believe, wishes to give M. Janssen the choice of having the Observatory built at Fontenay, as was originally decided upon, or at Vincennes, which is at a less distance from Paris.

MR. WATSON, at Monday's sitting of the French Academy, read a long and interesting paper on the observations of the Transit of Venus made at Peking station, of which he was the chief. The question of the atmosphere of Venus and the difficulty of determining the exact time of real contact were examined at full length. M. Leverrier expressed his decided opinion that the determination of the parallax of the sun by this method was useless unless some unexpected service should be rendered by photography for solving the difficulty raised by Mr. Watson. Mr. Watson tried to discover to what height the atmosphere of Venus was liable to cause optical disturbances by its illumination by the sun, and he found it to be fifty-five miles, about 1-70th the diameter of the planet.

THE Kirtland Summer School of Natural History (named in honour of Dr. Jared P. Kirtland) was inaugurated July 6, 1875, in Cleveland, Ohio (U.S.) The session this year extended through five weeks, closing August 9, with appropriate exercises. The school was founded on behalf of the Kirtland Society of Natural Sciences, by Prof. Theo. B. Comstock and Dr. Wm. K. Brooks. Instruction was given in botany and entomology by Prof. Theo. B. Comstock, of Cleveland; in general invertebrate zoology by Dr. Wm. K. Brooks, of Cambridge, Mass.; in microscopy and protozoa by Prof. Albert H. Tuttle, of the Ohio Agricultural and Mechanical College, Columbus, Ohio; and a short course of lectures on geology was given by Dr. J. S. Newberry, of Columbia College, New York City, Director of the Ohio Geological Survey. The work was all done in the laboratory and in the field, text-books being wholly discarded. Twenty-five enthusiastic pupils, many of them lady teachers, availed themselves of the advantages afforded for the small fee of ten dollars. The expenses were paid by a subscription fund, the instructors receiving but slight compensation by a division of the small balance in hand. The session was very profitable, and it is hoped that the school will be continued year after year.

THE French Department of the International Maritime Exhibition contains a large number of apparatus intended for the raising of wrecks from the bottom of the sea. Working models of these have been sent in by M. Bazin, an engineer. This inventor has organised an immense submarine observatory which enables the bottom of the sea to be inspected with perfect security. M. Roselli, an Italian engineer, exhibited a self-moving gigantic grapnel, which being worked by steam could render great service to raise even such heavy weights as the *Vanguard*. M. Bazin has also invented a ship for dredging at small depths when it is necessary to open a channel for a port. Several ships of this kind have been constructed for the Russian Government, and are now at work in Russian waters. The principle involves the use of syphons, which are let down to the bottom and are so worked as to send mud, sand, and water into the main hold of the vessel, from which they are taken out by powerful steam-engines.

A UNIVERSITY is to be founded at Tomsk, one of the chief towns of Siberia. The new establishment will have only two faculties, one of Law and the other of Medicine. The want of doctors in Siberia may be inferred from the fact that there are only fifty-five of them in a country which is as large as the whole of Europe, and whose population amounts to more than 6,000,000 inhabitants. The Russian Minister of Finance has granted a credit of 40,000*l.* on the revenue of the State for the new establishment, which will raise the number of Russian Universities to eight, seven others being already in existence, viz., St. Petersburg, Moscow, Kiew, Kazan, Kharkow, Odessa, Varsovie, besides two foreign Universities—a German one in Dorpat, and a Swedish one in Helsingfors. A new University is also to be established in Vilna.

CAPTAIN WATERHOUSE writes that he has verified Dr. Vogel's discovery of the influence of certain dyes in increasing the sensitiveness of bromide of silver to the less refrangible rays of the spectrum.

AN examination will begin at Merton College on Tuesday, October 12, for the purpose of electing to one Mathematical and one Physical Science Postmastership. The postmasterships are of the annual value of 80*l.*, and are tenable for five years from election, or so long as the holder does not accept any appointment incompatible with the pursuance of the full course of University studies. After two years of residence the College will raise by a sum not exceeding 20*l.* per annum the postmasterships of such postmasters as shall be recommended by the tutors for their character, industry, and ability. Further information may be obtained from the Mathematical and Physical Science Tutors.

MR. E. J. MILLS, D.Sc., F.R.S., has been appointed Young Professor of Technical Chemistry in Anderson's College, Glasgow, on the resignation of Prof. Gustav Bischof.

WE would direct the attention of zoologists to a sketch and description by Prof. Wilder, of Cornell University, in the *American Journal of Science and Art* for last month, of a fœtal Manatee whose total length is 3·7 inches. "The head (which is somewhat pig-like) is strongly flexed upon the chest, and the tail forms a right angle with the trunk;" a contour very different from the adult animal being the result. The specimen was obtained at Pebos, Peru, upon the Marañon, a tributary of the Amazons, by Prof. James Orton.

IN a letter to yesterday's *Times*, Mr. W. L. Watts gives a long description of a volcanic eruption which he witnessed last month on the Myvatns Orœfi, in Iceland.

THE Berlin Geographical Society has received a telegram from Lisbon, dated the 11th inst., announcing that Dr. Pogge and Lieut. Lux, with their African Exploring Expedition, were on their way from Cassandje to Lunda. Major von Homeyer was still on the coast.

SOME of our readers may be glad to learn that the *Philosophical Magazine* for the present month contains, in full, Mr Croll's paper on "The *Challenger* Crucial Test of the Wind and Gravitation Theories of Oceanic Circulation," read before the British Association.

THE second number of Mr. Flemming's *Veterinary Journal* maintains its promised standard of excellence. The original articles are instructive, and the manner in which the most recent home and foreign investigations are placed before the reader will add greatly to the facilities for acquiring advanced information. We would direct special attention to the translation, from the German, of Prof. Siedamgrotzky's observations on the Thermometry of the Domesticated Animals.

A NEW American fossil Crustacean from the Water Lime Group, named by its discoverers, Mr. A. R. Grote and Mr. W. H. Pitt, *Eusarcus scorpionis*, is described and illustrated by an excellent photograph in the last number of the *Bulletin of the Buffalo Society of Natural Science.* It is allied to *Eurypterus* and *Pterogotus*, but is peculiar in the narrowness of the cephalo-thoracic portion, and the sudden constriction of the terminal segments.

MR. WILLIAM LONGMAN has reprinted in a separate form his interesting article in the August number of *Fraser's Magazine*, "Impressions of Madeira," containing some interesting notes on the natural history, scenery, climate, and life of the island. A good map accompanies the paper.

THE Report of the Council of the Leicester Literary and Philosophical Society speaks hopefully of its position and prospects. The Society is now in its fortieth year, has more than 250 members, and is regarded as "the leading institution for the cultivation of literary and scientific tastes" in the town and county. The Society has resolved to commence the publication of Transactions by bringing out gradually a brief but complete history of the proceedings of the Society from the date of its formation. In speaking of the decreasing attendance on the lectures by eminent outsiders, the Report gives a hint to scientific lecturers which we reproduce here for the sake of those whom it may concern:—"It must be acknowledged that the professors have sometimes relied too much upon their reputation, and given to a critical audience mere badly arranged notes, or information which any handbook would supply. And it is not too much to say that the quality of the lectures delivered gratuitously by the Society's own members and friends is of such a character that the advantage on the side of the professors is not always very striking." We hope the Society will go on with increased vigour when it enters upon its new premises, and especially that the various sections will set themselves to organise really valuable practical work.

FROM the Third Report of the Leicester Town Museum, we notice that several important additions have been made during the year, and that the Committee are in earnest to make the collection serve a really educational purpose. We hope that when the new premises are ready and the Museum transferred, that it, like the Leicester Society, will take a decided step forward. We are glad to see that the gratuitous lectures in connection with the Museum have been fairly well attended.

WE have received the Fifty-fourth Annual Report of the Board of Direction of the Mercantile Library Association of New York. This library is the fourth largest in the United States, and contains upwards of 155,000 volumes, with a membership of upwards of 8,000. The library seems to be well administered and to serve a very useful purpose, and, to judge from the report of books added during the past year, contains a fair amount of scientific literature.

FROM the Forty-first Annual Report of the York School Natural History, Literary, and Polytechnic Society, we are glad to see that the first-named branch obtains a fair amount of attention.

THE night of July 7–8, 1875, will be long remembered in Switzerland for the thunderstorms, several of them of almost unexampled severity, which occurred in Val de Travers, Liestal, Lucerne, Argovie, Zurich, and St. Gall (Rapperswyl), Langenthal, Grisons, Valais, Fribourg, and Geneva. Of these, the thunderstorm which broke over Geneva was unprecedentedly severe and disastrous. A detailed account of the phenomenon has been sent us under the title "L'Orage du 7 au 8 Juillet, 1875. Extrait du *Journal de Genève*, du 9 au 12 Juillet." It appears to have originated to westward in the department of Ain, and took an easterly course up the valley of the Rhone to Geneva, on reaching which it spread over a wider area, and thence directed its course over Savoy. As midnight came on, though the heat was suffocating and not a breath of wind stirred below on the streets, light objects on the roofs of the houses began to be whirled about and carried off as by a tempest of wind. At the same time a dull rumbling sound, resembling neither that of wind nor that of thunder, announced the approach of the thunderstorm, and at 12 midnight exactly it burst over Geneva in all its fury. An avalanche of enormous hailstones with no trace of rain was precipitated from the sky, and shot against opposing objects by a tempest of wind from the south-west. In a moment the street lamps were extinguished, and in a brief interval incredible damage was inflicted, the glass and tiles of houses smashed to powder, trees stripped of their bark on the side facing the west, and crops of every sort were in many places all but totally destroyed. The smallest of the hailstones were the size of hazel-nuts, many were as large as walnuts and chestnuts, and some even as large as a hen's egg. Some of the hailstones measured four inches in diameter, and six hours after they fell weighed upwards of 300 grammes. For the most part the hailstones were of a flattish or lenticular form, with a central nucleus of 0·16 to 0·40 inch diameter, enveloped in several concentric layers of ice, generally from 6 to 8, alternately transparent and opaque. An interesting map accompanies the description, showing the districts where the storm was felt as well as the degree of its intensity in each locality. The electrical phenomena were very remarkable; the flashes of lightning succeeded each with so great rapidity from midnight till a few minutes after 1 o'clock in the morning, that a mean of from 2 to 3 were counted each second, or from 8,000 to 10,000 per hour. Electrical phosphorescence was remarkably intense before and during the hail. The ground, animals, prominent objects, as well as the hailstones, were strongly phosphorescent. Immediately after the hail, ozone was greatly developed, the smell being so pronounced as to be compared by nearly all observers to garlic. The incessant electrical discharges passed from cloud to cloud over a central point from which the hail fell, but thunder was very rarely heard.

THE additions to the Zoological Society's Gardens during the past week include a Syrian Fennec Fox (*Canis famelicus*) from Persia, presented by Mr. Edwyn Sandy Dawes; two Glaucous Gulls (*Larus glaucus*) from Greenland, presented by Capt. Loftus F. Jones; two Fork-tailed Jungle Fowl (*Gallus varius*) from Java, presented by Mr. W. Fraser; a Royal Python (*Python regius*) from West Africa, presented by Capt. H. T. M. Cooper; a Dotterell (*Charadrius morinellus*), European, presented by Dr. C. R. Bree; a Weeper Capuchin (*Cebus capucinus*), a Golden-crowned Conure (*Conurus aureus*) from South-East Brazil, eleven Blackish Sternotheres (*Sternothærus subniger*) from Madagascar, deposited; a Malabar Parrakeet (*Palæornis columboides*) from South India, a Blue-crowned Conure (*Conurus hæmorrhous*) from Brazil, two Burrowing Owls (*Pholeoptynx cuniculata*) from America, purchased.

SCIENTIFIC SERIALS

THE *American Journal of Science and Arts*, August.—The article on the observation of the corona and red prominences of the sun, by E. S. Holden, we have already reprinted. The other original articles are:—A note on Walker's Statistical Atlas of the United States, prepared by order of Congress. This is based on the census of 1870. Formerly the results of a census have been given in numerical form only; now much information is set forth in ingeniously contrived maps, of which there are sixty-five. Ten of the maps are prepared from data not derived from census returns, but which are of especial interest in such a work. The work is divided into three parts, the first relating to physical features of the United States. The relations of some of these maps to each other are very instructive. For instance, the relation between woodlands and rainfall and other climatic conditions has of late been the subject of much dogmatic theorising. A comparison of these maps shows that the forests of Washington Territory are in regions having an annual rainfall of sixty inches and upward. The magnificent forests found from Minnesota to Maine are in regions of twenty-eight to forty inches, a rainfall precisely identical with that of the nearly treeless prairies which extend westward from Chicago. The northern part of the Michigan peninsula with its heavy timber is marked with precisely the same rainfall as large portions of Southern Minnesota lying in the same latitude and nearly treeless. In the second section the interesting question of the "centre of population" is discussed. In 1790 it was about twenty-three miles east of Baltimore. It has travelled westward, keeping curiously to the 39th degree of latitude, never getting more than twenty miles north nor two miles south of it. In the eighty years it has travelled only 400 miles, and is still found nearly fifty miles eastward of Cincinnati.—On the chondrodite from the Tilly-Foster Iron Mine, by E. G. Dana. The chondrodite forms the gangue of the magnetite, being everywhere disseminated through it in varying proportions; it is identical with humite in chemical composition, and alike in crystalline form. The humite crystals are of three types, but until now the correspondence of the minerals has been known only for the second type. The Tilly-Foster mine affords crystals of all three types, and the comparisons between humite and chondrodite form the subject of this long article.—On an easy method of producing di- and tri-nitrophenetol, by P. T. Austen.—On a fœtal Manatee and Cetacean, with remarks on the affinities and ancestry of the Sirenia, by Prof. B. G. Wilder. There is added a list of writers on the subject.—On tidal waves and currents along portions of the Atlantic coast of the United States, by J. E. Hilgard.—On ancient glaciers of the Sierra Nevada, by Prof. Joseph Le Conte. The paper consists of a description of Fallen Leaf Lake Glacier, Cascade Lake Glacier, and Emerald Bay Glacier, a map of which district is given. Among the questions of a general nature discussed are:—Evidences of the existence of the great Lake Valley Glacier; Origin of Lake Tahoe; Passage of Slate into Granite; Glacial Deltas; Parallel Moraines; and Glacial Erosion.—Certain methyl and benzyl compounds containing selenium, by C. Loring Jackson.—Description of the Nash County meteorite which fell in May 1874, by J. Lawrance Smith.

Reale Istituto Lombardo, Rendiconti (vol. 8, fasc. xv.)—From this part we note the following papers:—On a supposed reform of the theory of electrostatic induction (second paper), by G. Cantoni.—On preventative measures against Phylloxera, by V. Trevisan.—On the intersections of a cone by a plane curve of the fourth order, by G. Jung.—On the central nucleus, and on the curves of resistance to rotation, through the flexion of transversal sections of prisms, by Antonio Sayno.

THE *Archives des Sciences Physiques et Naturelles* (No. 210, June 15) contains an elaborate review of M. Becquerel's work just published, "Des Forces physico-chimiques et de leur interprétation dans la production des phénomènes naturels."—A note by M. Hermann Fol, on the first origin of sexual products.—On the viscosity of saline solutions, by M. Ad. Sprung; the author first considers the influence of temperature, and then describes the relation existing between the velocity of effluence of a salt and its chemical composition.—A letter from M. E. Liais, dated Rio Janeiro, May 1st, 1875, and relating to the next oppositions of Mars with regard to the determination of the sun's parallax; and on the remarkable coincidence of the parallax obtained in 1860, with the new measurement of the velocity of light by M. Cornu.—On the determination of the sun's parallax by observations of the planet Flora, by M. Galle.

Poggendorff's Annalen der Physik und Chemie, No. 7 (1875).—This part contains the following papers:—On friction and conducting of heat in rarefied gases, by A. Kundt and E. Warburg.—Spectral analytical researches, by R. Bunsen (second paper.) This paper treats of spark spectra, flame spectra, and absorption spectra of elements, and is accompanied by several tables.—On the diathermancy of moist air, by J. L. Hoorweg.—On the experimental determination of the dielectricity constant of some gases, by L. Boltzmann.—On crystallisation products in ordinary glass, by Dr. Otto Schott.—On the penetration of gases through thin layers of liquids, by Dr. Franz Exner.—On a simple method to compare two sounding columns of air by means of sensitive flames, by Dr. Bresina.—An experiment on the electro-dynamical effect of the current of polarisation, by N. Schiller and R. Colley, of Moscow.—On a peculiar case of magnetisation, by J. Jannin (translated from the *Comptes Rendus*).—On the magnetic properties of iron prepared by electrolysis, by W. Beetz.—Spectro-electric tube or fulgurator, an apparatus serving for the observation of spectra of metallic solutions, by MM. B. Delachanal and A. Mermet.—A reply by Dr. K. Heumann to Herr R. Schneider's remarks on the decomposition of cuprous sulphide by nitrate of silver.—On the sudden breaking of glasses, by Ed. Hagenbach.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Sept. 6.—M. Frémy in the chair.—The following papers were read:—On the application of a new theorem of the calculus of probability, by M. Bienaymé.—Researches on the cold bands in dark spectra, by MM. P. Desains and Aymonet.—Eleventh note on the electric conductibility of bodies which are known to be only indifferent conductors, by M. Th. du Moncel.—Results from palæontological researches at Durfort (Gard), by M. P. Cazalis de Fondouce, made for the Museum of Natural History, by M. P. Gervais.—New nautical charts of meteorology, giving both direction and intensity of probable winds, by M. Brault.—On the superficial radiations of the sun, by Mr. S. P. Langley—Observations of the August meteors in 1875 by M. C. Wolf.—A note on Bernouilli's numbers, by M. E. Catalan.—On the larva forms of Bryozoa, by M. J. Barrois.—On two thunderstorms with hail observed on July 7 and 8, in some parts of Switzerland and the South of France, by M. Colladon.

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ERRATUM—P. 404, Col. 2, delete line 55.

THURSDAY, SEPTEMBER 23, 1875

HELMHOLTZ ON TONE

On the Sensations of Tone as a Physiological Basis for the Theory of Music. By Hermann F. Helmholtz, M.D. Translated with the author's sanction by Alex. J. Ellis, F.R.S., &c. (London: Longmans and Co., 1875.)

IN the general advance of scientific knowledge which has taken place during the last half-century, the science of acoustics has hardly received its fair share of attention. Founded on principles originated by the ancients, and afterwards extended by Galileo, Newton, Taylor, Sauveur, Bernouilli, Euler, Smith, Young, and others, the first great and complete work on it was "Die Akustik," of Chladni, published in Germany in 1802, but which is chiefly known by its French translation.

It acquired a high and wide reputation, and it has ever since been a standard authority on the subject. Sir John Herschel's celebrated treatise on Sound in the "Encyclopædia Metropolitana," carried the theoretical views of the science much further, and so supplied what was deficient in Chladni's more practical work; but nothing of importance has been added to our knowledge of the science from Chladni's time till about fifteen years ago.

It was then known that one of the most eminent physicists and physiologists of Germany, Herr Helmholtz, Professor of Physiology at Heidelberg, had been devoting considerable attention to the science of acoustics, and, if we recollect aright, some of his discoveries were brought forward by himself in lectures at our Royal Institution. In 1863 appeared a work by him, entitled "Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik," the result of eight years' investigations in acoustical science. This work not only gave much new information on acoustical subjects generally, derived almost entirely from the author's own long-continued investigations; but it published new and most important discoveries as to the nature of musical sounds, and valuable reflections on the bearing of these discoveries on the theory of music generally. The work met with high and universal appreciation among those who could understand it; it went through three editions in Germany, and was translated into French, which gave it a much wider circulation. Helmholtz's book has been followed by two popular works in English, namely, "Lectures on Sound," by Prof. Tyndall (1867), and "Sound and Music," by Mr. Sedley Taylor (1873), the chief object of both being to expound Helmholtz's discoveries and doctrines to English readers. We have now, however, a translation into English of the entire work, as mentioned at the head of our article.

In attempting to give some idea of the book, it is necessary to premise that it treats of two distinct kinds of subjects, physical and musical. In addition to being a profound and practised physicist, the author has clearly devoted much attention to the study of music, both theoretically and practically, and he has endeavoured to apply his physical discoveries and theories to the elucidation of many points connected with the art which he has found obscure. We may therefore divide our notice into these two heads.

In regard to the physical part of the subject, Helmholtz's work owes its greatest interest and its greatest fame to the entirely new light he has thrown on the nature of musical sounds, and the complete way in which he has explained and accounted for phenomena in regard to them which were previously very obscure.

A little attention will lead anyone possessing an ordinarily susceptible ear to the perception that a musical sound has three properties, each of which may be subject to a wide range of variation. These are: (1) its *pitch*, or its degree of acuteness or gravity in the musical scale; (2) its *strength*, or degree of loudness or softness; (3) the *quality*, or character of tone.

The question then naturally arises to what physical circumstances these three peculiarities are due. In regard to the two first there has been no great difficulty. It has been long known that the *pitch* of a musical sound depends on the rapidity of the vibrations which cause it, for according as the vibrations succeed each other more or less rapidly, the note produces sounds to us more acute or more grave, or, in other words, its pitch is higher or lower.

The *strength*, or degree of loudness or softness of a musical sound, has been also known to depend on the *amplitude* or extent of the vibrations, a larger amplitude giving a louder sound, and *vice versâ*.

The third property of musical sounds is their *quality* or peculiar character of tone. A violin, for example, gives a tone of a different quality from that of a clarionet, an oboe, a flute, or a trumpet, which all again differ from each other. The varieties of quality of tone that may be obtained are almost infinite; we not only possess an immense variety of musical instruments and means of producing musical sounds, all which have their individual qualities of tone, but even on the same instrument the same note may often be given several different varieties of character, independent of the mere loudness or softness. And that these infinite varieties are really objective physical differences, and not merely subjective or ideal, is proved by the facility with which educated ears can identify and distinguish between them, even sometimes to the minutest shades of difference. The stringed tribe of instruments, and still more the human voice, furnish ample examples of this.

The tone of a particular violin, or of a particular violin player, can be identified by a connoisseur among a hundred, and we all know that the varieties of quality of the human voice, even in the same register, are as easily recognised by the ear as the varieties of physiognomy are by the eye. And even in the same voice, the numerous varieties of vowel sounds producible are, when examined carefully, only varieties in quality of tone.

The nature of this property of sounds has hitherto been very obscure. Chladni, the great expounder of acoustical science in the early part of this century, says:—"Every real musical sound is capable of different modifications, whose nature is as yet entirely unknown, but which probably consist of some mixture of what is simply noise." He then explains at some length that this may arise either from peculiarities in the structure of the sounding body as regards material, &c., or from the nature of the body with which it is struck or rubbed, to produce the sound. He further adds the suggestion that such irregularities may be due to irregular tremblings of the smaller parts of elastic bodies.

Sir John Herschel ("Encyclopædia Metropolitana"), speaking of musical sounds, says: "Of their quality and the molecular agitation on which they depend, we know too little to subject them to any distinct theoretical discussion."

To put the problem clearly, suppose we have two musical sounds of the same pitch and the same degree of loudness, but of different qualities. To what physical cause is the difference in quality due? We know that the rapidity and the amplitude of the vibrations is the same in both cases; what other element of variation can enter into the phenomenon? Helmholtz is the first who has given a complete answer to the question.

It very seldom happens that a musical sound consists of one simple note; it is generally a compound of many notes combined together. To illustrate this by a simple example, suppose a stretched string, as a violin string or pianoforte wire, sounds any particular note. This note, which is called the fundamental one, will be due to the vibrations of the string as a *whole*, and if we could prevent any other kind of vibration this sound would be a simple one. But the string has a natural tendency (for reasons too recondite to enter upon here) to take upon itself other partial vibrations, and thereby to complicate the effect produced. It will divide itself spontaneously into two, three, four, five, six, or more aliquot parts, and each of these parts will set up an independent vibration of its own, giving a new note corresponding to its length. All these will sound together, and thus by the vibration of the string we get not only the fundamental note (which is usually the loudest and most prominent), but its octave, its twelfth, its double octave, its seventeenth, nineteenth, and so on, all heard in addition, and giving a sound which is a compound of them all. All the additional notes above the fundamental have been usually called in England *harmonics;* Helmholtz calls them *overtones* (obertöne).

We have given a string as a simple example of the mode of generation of a compound sound, but such sounds are produced in many different ways. A compound sound, so far as its effect on the ear is concerned, is due to a particular form of air-wave, produced in the instance given by the superposition of different sets of vibrations of the sounding body; and such a form of wave may be equally well produced by other means, such as a reed; or it may originate in the air itself, as in a flute. In every case where a given fundamental note is found, there is the same tendency for it to be accompanied by subsidiary fractional vibrations, producing corresponding overtones.

The phenomenon of compound sounds, as found by harmonics or overtones accompanying fundamental sounds, has been long known. It was mentioned by Mersenne as early as 1636, and has since been noticed by Bernouilli, Young, Rameau, Chladni, Sir John Herschel, Woolhouse, and others; but there is great difficulty in getting practical musicians, who have not been accustomed to considerations of this nature, to admit that what, judging by the practical impression on the ear, seems only a simple and single note, can really be one compounded of a great many sounds differing much in pitch, and some absolutely discordant. Helmholtz endeavours to combat this prejudice. He shows by several analogous physical and physiological examples that the senses are apt, in the presence of prominent facts, to ignore others which may be less prominent but equally real; and he reasons that as the fundamental note is almost always stronger than any of the others, the ear is inclined to refer the whole combination to that one note, and refuses to take the trouble of separating and identifying the various elements of the sound.

An example of artificial compound sounds, purposely made, is furnished by a large organ. The pipes from which its sounds arise are in themselves but weak, and no multiplication of them would give tones of great power. Hence the long experience of organ builders has led them to form compound sounds by adding to each note pipes speaking its octave, twelfth, fifteenth, and other "overtones," the effect of which is, as is well known, to produce sounds of almost powerful and penetrating quality. Yet, if these overtones are well proportioned, they give, to an ordinary hearer, only the impression of one single loud sound.

By a little practice the ear may be educated to distinguish and separate the various notes which make up a compound sound, and when the habit of doing this is acquired, the illusion disappears. But that no proof may be wanting of this important principle, Helmholtz has contrived mechanical means by which any sound may be analysed, like a ray of light or a chemical compound, and its component parts exhibited separately. He has contrived certain instruments called resonators, each of which will, like a chemical reagent, test the presence of a particular overtone, and by submitting these in succession to the vibrating influence of the compound tone, they at once show whether the sounds they are tuned to are present or absent therein.

We have dwelt at some length on this phenomenon of the compound nature of musical sounds, because it is in reality the great fact which underlies the whole of Helmholtz's researches in this volume, and he himself has accordingly taken great pains to demonstrate and explain it, knowing that, although not a new discovery, it was yet far from being generally acknowledged. Indeed, we consider the establishment of this fact, so difficult of acceptation by practical musicians, and yet so simple and obvious when explained, is one of the most useful and important features of that portion of the complete work now under review. This establishment and explanation he afterwards uses as the basis for most of his researches, namely, the compound nature of musical sounds.

Such sounds, we have shown, consist, in almost all cases, not of a simple vibration, but of a number of vibrations of different velocities, superposed upon a fundamental one. The whole thus form a compound vibration which, though it produces on the inexperienced ear the effect of a single note, is really, when analysed, a compound of this note with a number of "overtones" harmonically related to it.

Among the many novel uses Helmholtz makes of this fact, the most important, physically, is the way in which he deduces from it the explanation of the third property we have mentioned of musical sounds, namely, their quality or character of tone.

Chladni was perfectly aware of the complex and varied nature of the vibrations producing musical sounds, but he does not seem to have attached any importance to them in this respect; for he says (p. 48, ed. 1830): "Die Verschiedenheit der Schwingungsarten trägt meistens nur wenig zu einer verschiedenen Wirkung des Klanges bei."

Sir John Herschel (Encycl. Metrop.) appears to have doubted Chladni's assertion, for he hints clearly at the probable influence on the quality of the sound, of the *form of the air-wave* (which is only the result of the complex vibration); and we may probably consider this to be the first hint on record pointing to Helmholtz's discovery.

Mr. Woolhouse, in an admirable little "Essay on Musical Intervals, Harmonics, &c.," 1835, goes further. He says (p. 77), speaking of the complex vibrations of a string: "The various combinations of these different modes of vibration must have a considerable influence on the musical quality and expression of the musical sound," which is a still nearer anticipation of the later doctrine.

Still, however, these anticipations were only guesses; it was reserved for Helmholtz to put the matter in the shape of a scientifically demonstrated fact. He has shown, by the most elaborate and conclusive investigations, that the *quality of a musical tone depends chiefly on the number and on the comparative strength of the various harmonical notes of which the tone is compounded.*

The overtones accompanying a fundamental note may be present in greater or less number, and they may vary considerably in comparative loudness or softness, and it is on the combination of these sources of variation that the quality of the tone will depend—or, to put the explanation in another and more scientific shape; as the *pitch* of a sound depends on the length or the frequency of recurrence of the air-wave, and the *loudness* on the degree of disturbance of the particles of the air therein; the *quality* of tone depends on what is called its internal *form*, or on the varieties of arrangement of expansion and compression of the air contained within one complete periodic cycle of oscillation.

Some modification in effect is often produced by a sound being accompanied by unmusical noises, such as the escaping of imperfectly used wind in a pipe, the unskilful scratching of the bow on a violin, the beating of reeds, and so on; but these are rather impurities than varieties of tone, and may be excluded from consideration.

There are very few natural sounds which are entirely simple, consisting of the fundamental note only. They are best produced artificially by means of the "resonators." The nearest approach to them may be found in the larger stopped wood pipes of an organ, an old-fashioned (not a modern) flute, and a tuning-fork after the sharp ring has subsided. The vocal sound of the Italian U (our *oo*) is also nearly a simple one. These examples will give the idea that simple tones are soft, dull, and entirely devoid of what is called brilliancy.

The addition of overtones gives this brilliancy and at the same time adds life, richness, and variety. It is to them that we owe entirely the agreeableness and pleasurable effect of musical tones. In proportion as the higher overtones predominate, so will the sound be bright and sparkling, or if in great predominance it will become metallic, thin, and wiry. If, on the other hand, the upper tones are weakened and the lower strengthened, the tone becomes more full, rich, and mellow. All the qualities of tone most esteemed and most useful in music are rich in overtones.

Helmholtz gives many examples of musical sounds of different character, which have been analysed according to his method. The tones produced from strings are peculiarly adapted to this purpose, because the vibrations so produced admit not only of mathematical calculation, but of ocular observation, and so give direct means of comparing the new theory with the facts, the result in all cases being most satisfactory and conclusive. The overtones in strings depend largely on the kind of impulse and the place where it is applied. In an ordinary piano the first six overtones are all audible, the three first strong, the fifth and sixth weaker, but still clear. The seventh and ninth, which are inharmonious, are excluded by striking the string in a peculiar place which does not admit of their generation. To prove the dependence of the quality on the strength of the overtones, Helmholtz has calculated mathematically what the strength of the first six overtones ought to be when produced with hammers of different degrees of hardness, and finds they should be as follows:—

	1.	2.	3.	4.	5.	6.
With a very hard hammer ……	100	325	500	500	325	100
With a medium hammer ………	100	249	243	119	26	1
With a very soft hammer ………	100	100	9	2	1	0

Now, as everybody who knows anything about pianofortes is aware that the tone is full and rich with a soft hammer, and hard and jangling with a hard one, it will be seen how admirably the mathematical results correspond with the actual ones, and how both confirm the theory.

Again, it is easily shown, both mathematically and practically, that thin wires will vibrate in short lengths much more easily than thicker and stiffer ones, and will therefore be more liable to produce the higher overtones, and hence the well-known metallic jangling of thin wires. This is the scientific explanation of the improved tone from the use of thicker wires in modern pianos, inasmuch as they admit of a more powerful blow without the production of the high and unfavourable overtones that would result from such a powerful impulse on a thin string.

The peculiar tones of the violin tribe, wind instruments, wood and brass, organ-pipes of various kinds, and so on, are all satisfactorily investigated in this way.

Helmholtz devotes much attention to the phenomena of vowel sounds, which had been already investigated by Willis and Wheatstone. He has completed their investigations by bringing the vowel sounds within his theory, and his elegant discussion of the subject, and the important results he obtains, are among the best features of his book.

All the above results we have mentioned have depended on the *analysis* of musical sounds. But the author has not stopped here. In chemistry, when a discovery has been made of the constitution of a compound body, by analysing it into its constituent elements, the efforts of the chemist are naturally turned to the converse process of proving the same proposition by synthesis, or by combining the single elements and showing that they will produce the compound. This proof has not been wanting in the present case, for Helmholtz has succeeded in combining simple sounds together in such a way as to produce imitations not only of vocal sounds, but of many other peculiar qualities of tone; not perfectly, from the extreme difficulty of imitating exactly all the minute shades of difference that enter into the combination, but still with enough success to demonstrate the general argument.

We have given especial prominence to Helmholtz's discoveries on the nature of musical sounds, because this is in reality the great feature of his work, by which it first acquired its fame, and by which his name will hereafter be honoured. But the physical part of the book contains much beside this that is important and interesting. His explanations on the general phenomena of acoustics are most lucid, and often very original; and his descriptions of the mechanism and action of the organs of hearing, coming from one of the highest authorities in physiology, are exceedingly instructive and valuable.

In Part II. the author enters into an investigation of what are called *beats*—a subject which has been heretofore very obscure—and also of other acoustical phenomena called "combination tones," which, though known since the time of Tartini, have not been thoroughly understood till Helmholtz gave their explanation. Into these matters we have not, however, space to follow the author: those who are interested in them can refer to the book for themselves.

Before we leave the physical part of the work it will be only just to testify to the excellence of the translation. Mr. Ellis is so well known as a philologist and a man of science, that his competence to deal with the work in a literary and scientific point of view requires no comment, and English readers may be satisfied that in this translation they have the original faithfully put before them. His work has evidently been a labour of love, and he deserves the highest credit for the trouble he has taken over it.

At the same time all men are fallible, and when a great authority condescends to do a work that could hardly be expected from him, we must not be unprepared for some little waywardness on his part, and there are a few things which we would rather have seen otherwise done. The title of the book is unfortunate; for, although no doubt "The Sensations of Tone" is a correct translation of "Tonempfindungen," yet to many English ears it will, we fear, sound strange and unintelligible from the fact that we are hardly accustomed in our language to understand the word "tone" in the sense here intended. The English title certainly does not give to the English reader anything like the same idea as the original title, "Die Lehre von den Tonempfindungen," does to an educated German. The strict rendering of a German phrase does not always correctly represent the original; for example, in speaking of the clever little tract of Hauslick, "Ueber das Musickalisch Schöne," Mr. Ellis translates it, "On the musically beautiful," whereas, as every reader of the tract well knows, the more appropriate expression in English would be "On the beautiful in music."

But the chief fault we have to find in the translation is the rendering of a term which of all others is the most important in the whole work, and in which the translator has, we conceive, taken a liberty not altogether justifiable. Helmholtz, in describing the compound nature of musical sounds, has called all the sounds above the fundamental one by the name of "obertöne," a word exceedingly appropriate, useful, and expressive, inasmuch as it at once defines and includes all these sounds in one appellation. Prof. Tyndall, in his *résumé* of Helmholtz's discoveries, has most naturally and with great propriety translated this term by the word "overtones." It exactly expresses the German in the simplest way, and it is as perfectly admissible into English as "overcoat" or "overseer."

Unluckily, Mr. Ellis is either too proud to adopt this word or has taken otherwise a dislike to it; for, on the ground that he does not consider it good English, he substitutes for it the expression "upper partial tones." This is not only clumsy and roundabout, but it is imperfect and wrong, inasmuch as it does not include, as the original expression does, the *whole* of the sounds above the fundamental, and gives no means of distinguishing higher overtones from the lower ones. As these overtones play such an exceedingly important part in Helmholtz's work, we cannot but consider, with all respect to Mr. Ellis, this rendering a blot on the translation which we very much regret.

We must reserve our notice of the musical portion of Helmholtz's work till a future opportunity.

OUR BOOK SHELF

Guide to the Geology of London and the Neighbourhood (Geological Survey of England and Wales). By William Whitaker, B.A., F.G.S. (London: Messrs. Longmans and Co., 1875.)

It is a matter of great satisfaction to geologists that the Geological Survey are again giving to the public some of the accumulated stores of information of which they are necessarily possessed, by resuming the series of large and complete memoirs which had been in abeyance for many years before the publication of "Whitaker's Geology of the London Basin," Part I., in 1872—a series now so well continued by the works of Judd and Topley. These, however, are comparatively expensive, and enter into minute details, so that although the whole of the information contained in the small book under notice has already been given at greater length in Mr. Whitaker's work mentioned above, or will be in a similar promised publication on the "Drifts of the London Basin," it will be of great use to a large number of persons who would not care for a more detailed description. A special Geological Map of London and its Environs, with all the Drift beds indicated, has lately been published, and for the last two years the Geological Model of London on a six-inch scale has been the admiration of all visitors to the Jermyn Street Museum: the pamphlet now before us is designed as a handbook to these. It commences with a description of the construction of the model, a matter of no small difficulty, considering the accuracy of the representation. The description of the various formations which enter into the London area, with their resulting features and scenery, though necessarily short, contains the cream of all the known facts, and what is better still, the reasons for all the not self-obvious determinations of the age and relations of the beds. Another most valuable portion is the series of tables of localities where the different formations may now be studied, showing no less than 154 places worthy of a geological visit within twenty miles of London. With regard to the general structure of the district, Mr. Whitaker is careful to refute the idea that the Tertiary beds were deposited in an eroded hollow of the chalk, as is often supposed; unfortunately, however, his section gives them rather the appearance of being so. We should also notice that although, on the evidence of fragments of Ammonites and Belemnites, he prefers to refer the red beds of the Kentish Town section to the Lower Greensand, none of this formation is represented in the section as lying beneath this part of London.

This convenient little publication, so full of valuable and condensed information, for so small a sum, will be of such great use to the members of the numerous field clubs, that we fear it will soon be out of print. What are 500 copies among so many who would wish to have it?

Snioland; or, Iceland, its Jökulls and Fjalls. By William Lord Watts. (London: Longmans and Co., 1875.)

In a recent number (vol. xii. p. 333) we published a letter from Mr. Watts announcing the important fact that he had succeeded in crossing the Vatna Jökull. So far as is known, this is the first time that this jökull (which means "glacier," and is probably cognate with the latter part of our word ic-*icle*) has been crossed, and the fact is creditable to Mr. Watts's determination and perseverance. The little book before us contains a narrative of an unsuccessful attempt to accomplish the same object, made by Mr. Watts in the summer of 1874. We regret to have to say that the narrative is a disappointing one. It is in the form of a rough diary, which seems to have been sent to the press in its crude form and published with little or no revision. A large portion of the book is occupied with a statement of the many difficulties, petty and serious, which Mr. Watts and his party encountered in the journey from Reykjavik, by the Geysers, Hekla, and the Myrdals Jökull to the Vatna Jökull, and there is really very little information about the region through which he passed. The entire narrative is extremely vague and unsatisfactory, and if Mr. Watts has any literary faculty, he certainly does not show it here; the reading of his narrative is a heavy task. Mr. Watts ought to know a great deal about the region with which this narrative is concerned, and especially about the jökulls in the south of Iceland, and we would advise him to put this information into a systematic form, make but little reference to the difficulties he encountered, obtain a few photographs on a much larger scale than the insignificant things which appear in the present work, and we have no doubt he would make a substantial contribution to our knowledge of Iceland. The party succeeded in getting only about half across the Vatna Jökull, when, from want of the necessary means to go further, they were compelled to turn back, after Mr. Watts had rather unnecessarily and sensationally planted the union jack at his furthest point. Mr. Watts's carelessness, to put it mildly, extends even to his use of language. The use of "laid" for "lay" might possibly be justified by eminent precedents; "peninsular of rock" may be a misprint, but "pulverent" is unjustifiable, and "molusc" is shocking.

Perhaps the most tangible piece of information conveyed by Mr. Watts is contained in the following paragraph:—

"To sum up, this hitherto untrodden Vatna Jökull is a mountainous tract, surmounted by a rolling plateau, containing numerous volcanoes, one or more of which, upon the north, appear to be in a state of pretty constant activity, while numerous others in all probability are paroxysmal, most likely exhibiting all the phenomena characteristic of (if I may be allowed the term) *bottled up volcanoes*. This tract, together with the Odatha-hraun, and the centre of Iceland with its numerous mountains, is a new volume of Nature, the first leaf of which has only just been cut, but whose secluded fastnesses will amply repay investigation."

In an appendix Mr. Watts gives some information as to equipment, which intending travellers in Iceland will find useful. The map at the end is on too small a scale to be of much use.

The main object of Mr. Watts's narrative is to attract attention to Iceland and induce travellers to co-operate in its exploration. We hope the work will serve this laudable object, as there is no doubt Iceland presents a handy and fertile field for explorers. Mr. Watts himself deserves great credit for what he has already achieved; we hope he will continue his work, and in a future publication add something of permanent value to our knowledge of the interesting island.

Report on the Neilgherry Loranthaceous Parasitical Plants destructive to Exotic Forest and Fruit Trees. By George Bidie, M.B., Madras. (Printed by E. Keys, at the Government Press, 1874.)

Surgeon-Major Bidie has in this volume presented to the Indian Government a report on the parasitical plants which prove destructive to forest and garden trees on the Neilgherries, and on the best mode of remedying the evil. The whole of these destructive parasites belong to one natural order, Loranthaceæ, represented in this country by a single species, the Mistletoe, and to two genera, *Loranthus* and *Viscum*. The fruit of the Loranthaceæ is characterised by the envelopment of the seed in a layer of a viscid substance, described by Dr. Bidie as intermediate in character between resin and india-rubber. Outside this viscid layer is a pulpy body which serves as food for birds and squirrels. After devouring this the seed is rejected, or, in the case of squirrels, passes uninjured through the body, and then adheres to the bark of any tree on which it may be cast. If the immediate conditions are unfavourable, the seed will be preserved in a state capable of germination for a very considerable time beneath its viscid covering. With regard to the mode of germination, Dr. Bidie has nothing to add to the information already furnished by Mr. Griffith and Dr. Hooker. With reference to the mode of attachment between the parasite and the host, the author states that although very firmly attached, there is no actual interlacing of the tissues; and that in some instances, after maceration in water for a few days, the parasite could be separated from the host without much difficulty. It is noteworthy that native Indian trees and shrubs do not appear to suffer nearly so much from the attacks of the Loranthaceæ as introduced, especially Australian, species. One foreigner, however, which appeared quite exempt from their ravages, was the "blue gum," the *Eucalyptus globulus*, which has already so many other useful qualities placed to its credit. Dr. Bidie asserts that the Loranthaceæ derive their nutriment not from the descending elaborated, but from the crude ascending sap of the host; hence their need for green foliage containing chlorophyll and possessing stomata, in which other parasites are deficient. The volume is embellished by fifteen large lithographs representing the different species, and illustrating the structure of the fruit and the mode of parasitism of the order.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Personal Equation in the Tabulation of Thermograms, &c.

Mr. Plummer, in his letter (Nature, vol. xii. p. 395), has missed the point of the review of the work of the Meteorological

Office referring to the tabulation of temperatures (vol. xii. p. 101). From 1,283 estimations of tenths of seconds, as tabulated by the highly-trained and experienced observers at Greenwich, he shows that the whole seconds estimated were 15 per cent. of the whole number, and thereupon remarks that this is precisely the excess of whole seconds that is taken in the review of the work of the Meteorological Office as indisputably proving the carelessness of the tabulations at the Kew Observatory. This is a mistake. Kew was not singled out for criticism because the whole degrees tabulated there amounted to 15 per cent. of the whole number, but because of "the irregularity of the tabulations, more especially as regards the tabulations from day to day." An examination of the tabulations at Kew from day to day shows that there are first-class tabulators in that Observatory, but it also shows there are others whose work is inferior. Thus, in the first published sheet for Kew, viz., January 1874, on seventeen of the days the whole degrees tabulated amounted on each of these days to at least 25 per cent., and the average of the whole seventeen days reached 31 per cent., or nearly a third of the whole. On the remaining fourteen days of the month the average was 14 per cent. Hence the variations of the numbers of whole degrees from month to month, which, as stated in the review, were 172 for January, 87 for February, 127 for March, and 94 for April. It is this irregularity in the work of tabulation which has lowered the character of the work done at Kew.

The averages calculated from 6,696 tabulations showed that the number of whole degrees read off at the seven observatories were 8·4 per cent. of the whole at Stonyhurst, 15·0 at Kew, 19·5 at Aberdeen, 21·2 at Armagh, 23·7 at Falmouth, 24·7 at Valencia, and 24·8 at Glasgow. So far as the mere average numbers are concerned, the tabulations at Stonyhurst and Kew are satisfactory; not so, however, is the work done at the other five observatories, especially the last three, where, on an average of 6,696 tabulations, a fourth part of all the numbers tabulated were whole degrees. For particular months the percentages are sometimes very large. Thus, at Aberdeen during January 1875, the following are the percentages of the different decimal places of the dry-bulb readings as printed by the Office:—

Decimal places.	·1	·2	·3	·4	·5	·6	·7	·8	·9	·0
Percentages.	11	6	5	7	6	6	6	5	9	39

From this examination it is seen that 50 per cent. of the whole readings are assigned to two of the decimal places, viz. ·0 and ·1, of which 39 per cent. are whole degrees. The largest percentages are not, as in the cases adduced by Mr. Plummer, distributed in different parts of the decimal scale, but stand together, viz., ·9, ·0, and ·1. As regards the column for each particular hour, out of the thirty-one readings, nineteen whole degrees occur in the 5 A.M. column, eighteen in the 8 P.M. column, sixteen in the 5 P.M., fifteen in the 6 A.M., fourteen in the 4 P.M., thirteen in four of the columns, twelve in six, and so on, down to eight whole degrees in one column, and seven in another, than which no fewer whole degrees occur in any column. It is unnecessary to make any remark on these figures.

The Meteorological Office has published in their Quarterly Weather Reports the monthly extremes of temperature in two forms, viz. in figures, and in curves of temperature. These were compared and the results stated in the review, from which it was shown that as regards the first month's extremes, fourteen in number, there were twelve errors in the numbers as published by the Office; and as regards the first year's extremes, 168 in all, there occurred forty-one errors of temperature varying from 0°·4 to 9°·6, and twenty-two errors as regards the day and nine errors as regards the hour of occurrence. Altogether twenty-nine months have been examined with the general result of an average of fully four errors in stating each month's fourteen extreme temperatures. Now it is on the large proportion of errors made in stating the extreme temperatures (for the prevention of which one of the twenty-seven regulations for the Director of the Central Observatory was specially designed), taken in connection with such results as those given above for one of the observatories for January last, that the charge of inaccuracy in this very costly but vitally important part of the work of the Meteorological Office is based. This charge, Mr. Plummer's letter in no way meets. The simple course is to see that this department of the Meteorological Committee's work, including that of the outlying observatories, be brought under some sort of satisfactory control.

THE REVIEWER

Ocean Circulation

As the strength of Mr. Croll's conviction that he has completely demolished the "gravitation theory" of oceanic circulation by the "crucial test" to which he subjected it before the Geographical Section of the British Association, is not unlikely to influence the minds of some, I shall be glad to be allowed to point out (1) that I have never denied the existence of a horizontal "wind-circulation," and (2) that the doctrine to which he applied his test was not mine, but a creation of his own. For his whole argument was based on the assumption that the ocean is in a state of static equilibrium; whereas the theory I advocate, which was originally advanced by Lenz, and which Sir William Thomson (in commenting upon Mr. Croll's paper and my reply to it) pronounced to be a matter "not of argument, but of irrefragable demonstration," is, that the ocean never is and never can be in a state of equilibrium, so long as one part of it is subjected to polar cold, and another to equatorial heat; but that it is in a state of constant endeavour to recover the equilibrium which is as constantly being disturbed.

If the boiler and water-pipes of a heating apparatus be filled with water whose temperature is that of the building in which it is placed, the whole mass of fluid *is* in a state of equilibrium; but the lighting of the fire beneath the boiler disturbs that equilibrium, and produces a circulation, which will be maintained as long as the water is being alternately heated in the boiler and cooled by the atmosphere of the building.

Suppose that the elongated basin of the Mediterranean, instead of lying E. and W., were to be turned N. and S., so that its water, instead of being exposed (as at present) to a practical identity of thermal influences, should be subjected at one end to arctic cold and at the other to almost tropical heat: instead of remaining in its present state of nearly perfect equilibrium, it would have a circulation like that which I have exhibited in the trough-experiment.

The only objection raised by Mr. Croll which has even a show of validity, is based on the supposed "viscosity" of water, which he asserts to be sufficient to prevent the disturbance of thermal equilibrium from exerting the effect which the "gravitation theory" attributes to it. This assertion has now been completely disproved by the masterly investigations of Mr. Froude; who has demonstrated experimentally—what the "wave-line theory" of Stokes, Rankine, and Sir William Thomson had rendered probable—that in the resistance to the motion of a ship through the water, the viscosity of the water itself is so small an element that it may be practically thrown out, water behaving as a nearly "perfect fluid," except where it moves over solid surfaces. Mr. Froude (in conversation with me) not only sanctioned my conclusion that a constantly renewed disturbance of thermal equilibrium *must* produce an oceanic circulation, but mentioned as an instance of the very small difference of downward pressure necessary to sustain such a circulation, that he had ascertained by repeated observation at the mouths of harbours, lochs, and fiords, that wherever the water within has its salinity at all reduced by a mixture with fresh water, there is an underflow of sea-water setting inwards, precisely as in the Baltic and Black Sea Straits.

Mr. Croll attempted to draw a further disproof of the "gravitation theory" from the *Challenger* observations on the temperature of the upper strata of the Antarctic Sea, at and near the ice-border. These observations show that a stratum of water of from 32° to 29° overlies a stratum of from 34° to 32°; which is considered by Mr. Croll as a death-blow to my assumption that the coldest water sinks to the bottom. Now, since I have repeatedly pointed out that the water of melting field-ice, and *à fortiori* that of melting icebergs, will float on ordinary sea-water colder than itself, in virtue of its inferior salinity, and since Capt. Nares distinctly speaks of the cold surface-stratum as having this origin, it does seem to me not a little strange that Mr. Croll should have overlooked this consideration. It is obvious that, for the reason just stated, the descent of the cooled surface-stratum cannot take place in the polar summer *at or near the margin of the ice*: but that it takes place wherever and whenever the surface-cold is sufficient to check surface-liquefaction, and to cool down water of ordinary salinity to a temperature below that of the subjacent stratum, it will be hard for Mr. Croll to disprove.

I cannot but greatly regret that Mr. Croll abstains from subjecting his conclusions on this subject to the test of *personal discussion*. For if he would bring them (as I have brought my own) under the criticism of the Mathematicians and Physicists of Section A, he would find that, notwithstanding the acceptance which his endeavour to solve the climatal problems of past epochs by astronomical computation has very deservedly met with on the part of Geologists, his denial of the possibility of a thermal circulation in the ocean is utterly repudiated alike on mathematical and on experiential grounds, by those whose authority as physicists ought to make him feel less confident in his own conception of the question. W. B. CARPENTER

Source of Volcanic Energy

A FEW words of explanation are necessary concerning my letter which appeared in NATURE, vol. xii. p. 396. Mr. Mallet's *prime* source of energy for producing tangential pressures is the force of cohesion developed in a cooling globe, gravitation giving only partial assistance; and when I spoke of "gravitation of the whole mass to itself," I wished to convey that, setting aside altogether the force of cohesion and its accompanying motions, there still remains the force of gravitation, which, acting in a globe of such size as the earth, and composed of heterogeneous materials, must of itself produce enormous local pressures.

Mr. Fisher objects to my supposing the possibility of the development of heat without room being left for motion, but so far as I understand the doctrine of energy, it is only necessary to have *force* for the production of heat when motion is impossible.

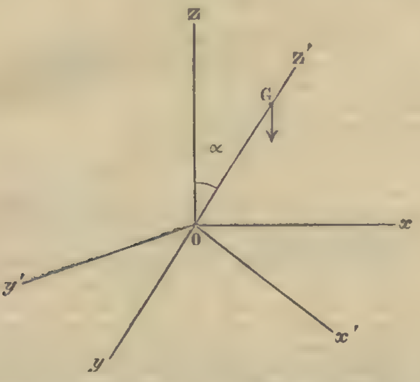
In Mr. Fisher's interesting paper his objection appears to be to the localisation of *fusing*, and not to the localisation of heat, fusing in some cases being prevented by the accompanying pressure. But in my little diagram I attempted to explain that the forces producing the high temperature might act in one set of strata, the neighbouring strata above and below at the same time being under much lower pressure, the pressure upon them being equal to the pressure of the rocks doing the work, minus the cohesion of said rocks; this difference of pressure being sufficient to allow one set of rocks to melt while others are crushed.

Kenmare, Co. Kerry WM. S. GREEN

Gyrostat Problem: Spinning-top Problem

IN vol. xi. p. 424 is given the solution, by Sir W. Thomson, of his gyrostat problem at p. 385. I venture to send a slightly different method* of obtaining the result (far inferior to Sir W. Thomson's in elegance and simplicity), in which Euler's equations for the motion of a rigid body about a fixed point are employed.

1. Take point of suspension for origin; the string for axis of z. The axis of the wheel Ox' revolves in horizontal plane xOy with uniform angular velocity Ω, and the wheel revolves round its axis Ox' with angular velocity w_1. The weight of wheel and axis will have moments round an axis Oy' in horizontal plane perpendicular to Ox'. Let $w' =$ weight of wheel and axis; A, B, B, moments of inertia round Oz, Ox', Oy'; w_2 angular velocity round Oy' at time t; $a =$ the distance of C. G. from Oz, xO$x' = \phi =$ angle described by Ox' in time t. Taking moments about Oy', we have



$$\frac{B\,d\,w_2}{d\,t} + \overline{A - B}\,w_1\,\Omega = w'\,a\,g \quad . \quad . \quad . \quad (1)$$

(Pratt, "Mech. Phil." 446). Also since there is no velocity about an axis in horizontal plane perpendicular to resultant axis of $w_1\,w_2$,

$$w_1 \sin.\,\phi - w_2 \cos.\,\phi = 0 \quad . \quad . \quad . \quad . \quad (2)$$

where $\phi = \Omega\,t.$

$\therefore \frac{d\,w_2}{d\,t} = w_1\,\Omega \sec.\,^2\phi = w_1\,\Omega$ for $t = 0$ in (1), since w_1, Ω are independent of the time; whence (1) becomes

$$A\,w_1\,\Omega = w'\,a\,g,$$

where $A = w\,k^2, \Omega = \frac{1}{4}$ . . . . Q.E.D.

2. A similar question (concerning a spinning top) was proposed in the Senate House, Cambridge, in 1859, of which indeed the preceding is a particular case.

A uniform top spins upon a perfectly rough horizontal plane, its axis being inclined to the vertical at a constant angle α, and revolving about it with constant angular velocity Ω. Prove that the velocity of rotation of the top about its axis must be $\frac{(a^2 + k^2)\,\Omega^2 \cos.\,\alpha + g\,a}{k_1{}^2\,\Omega}$, where a is the distance of the centre of gravity from the extremity of the peg, $k'\,k$ the radii of gyration about the axis of figure, and about an axis through C. G. perpendicular to it respectively. Take O, the extremity of the peg, which remains fixed, as origin, and let O Z' be position of axis at any time t; O G $= a$; Z O Z' $= \alpha$. Let $M =$ mass of the top; A, C, C, moments of inertia about O x', O y', O Z' (rectangular axes moving with the top); $w_1\,w_2\,w_3$, angular velocities about O x', O y', O Z' at time t.

The intersection of planes x O y, x' O y' will move round O Z with angular velocity Ω. Let $\phi =$ angle which O x' makes with this line.

If we take moments about O x', we have by Euler's equations (Pratt, art. 446)—

$$\frac{A\,d\,w_1}{d\,t} + \overline{C - A}\,w_2\,w_3 = M\,g\,a \cos.\,z\,y^1 \quad . \quad . \quad (1)$$

Also $w_1 = \Omega \sin.\,\phi \sin.\,\alpha$, $w_2 = \Omega \cos.\,\phi \sin.\,\alpha$, $w_3 = \frac{d\,\phi}{d\,t} + \Omega \cos.\,\alpha$

$$\cos.\,z\,y^1 = \cos.\,\phi \sin.\,\alpha \text{ (ibid. 447)};$$

$$\therefore \frac{d\,w_1}{d\,t} = \Omega \cos.\,\phi \sin.\,\alpha \frac{d\,\phi}{d\,t} = \Omega \cos.\,\phi \sin.\,\alpha\,(w_3 - \Omega \cos.\,\alpha).$$

Substituting in (1) and reducing, we get—

$$C\,\Omega\,w_3 = M\,g\,a + A\,\Omega^2 \cos.\,\alpha. \quad . \quad . \quad . \quad (2)$$

But $A = M\,(k^2 + a^2)$, $C = M k_1{}^2$;

$$\therefore w_3 = \frac{g a + (a^2 + k^2)\,\Omega^2 \cos.\,\alpha}{k_1{}^2\,\Omega}.$$

If $\alpha = 90°$ in equation (2), we get the solution of the preceding question as a particular case. F. M. S.

Arnesby

OUR ASTRONOMICAL COLUMN

THE MASS OF JUPITER.—M. Leverrier has made a special communication to the Paris Academy of Sciences with reference to the bearing of his researches on the motion of Saturn, in a period of 120 years, on the value of Jupiter's mass. Laplace, in the *Mécanique Céleste*, had fixed $\frac{1}{1067{\cdot}09}$ making use of the elongation of the fourth satellite as determined by the observations of Pound, the contemporary of Newton, observations of which it appears we have no knowledge, except from the reference to them in the "Principia;" subsequently Bouvard, comparing Laplace's formulæ with a great number of observations, discussed with particular care, constructed new Tables of Jupiter, Saturn, and Uranus, in which important work he formed equations of condition, wherein the masses of the planets entered as indeterminates, and by the solution of which their values adopted in the Tables were obtained. The denominator for Jupiter's mass, expressed as a fraction of the sun's taken as unity, is 1070·0, and Laplace stated that on applying his theory of probabilities to Bouvard's equations it appeared to be nearly a million to one against the error of the mass thus deduced, amounting to one-hundredth part of the whole. M. Leverrier then refers generally to the discussion of the observations of several of the minor planets with the view to correcting the mass of Jupiter, and to the observations of elongations of the fourth satellite by the present Astronomer Royal at Cambridge, which last assigned for the denominator of the fraction 1046·77. He then remarks upon the circumstance of Bouvard having deduced from his comparison of the theory of Saturn with seventy-four years' observations a mass so nearly identical with that of the *Mécanique Céleste;* Bouvard left no details of his work behind him; it is only known that he adopted at the outset the value of Jupiter's mass admitted at the time, that of Laplace, and M. Leverrier explains that on the method of procedure adopted, Bouvard could not do otherwise than reproduce at the termination of his calculations the value he had assumed at starting. This is illustrated by the result of Leverrier's solution of his own equations of condition, founded upon the much longer period of 120 years, which proved wholly insufficient for the correction of Jupiter's mass. He remarks, with respect to Bouvard's work, that any value of the mass taken arbitrarily within certain limits will allow of a tolerable representation of the observations of Saturn, on the condition that this same arbitrary value is introduced throughout in the functions representing the mean longitude, mean motion, excentricity and longitude of perihelion; the elements obtained by Bouvard are therefore found represented by these functions of his arbitrary quantity, and he reverts to the mass assumed at the commencement of his work.

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* A comparison of this method with Sir W. Thomson's (which is virtually the same as that adopted by Airy in his tract on Precession and Nutation) is instructive as illustrating the dynamical meaning of Euler's equations.—ED. NATURE.

In conclusion, M. Leverrier insists that the use of the elongations of the fourth satellite for the determination of the mass of the Jovian system, has at present an incontestable superiority over the employment of the theory of Saturn, on account of the too short period over which the observations as yet extend, but in the lapse of time this superiority of the former method will diminish and the use of the perturbations will become the more advantageous. It is really, he adds, the same question as that which presents itself with regard to the solar parallax, which is determinable on two methods: the one, geometrical, the method by transits of Venus; the other, mechanical, depending for instance on the large inequalities in the motion of Mars. The method by transits, so important in 1760, but limited in its means of application, must eventually give way to the method of perturbations, the accuracy of which will increase unlimitedly with the course of time.

The first evaluation of the mass of Jupiter is that of Newton in the Cambridge edition of the "Principia" (1713), inferred from Halley's observation of an emersion of Jupiter and his satellite from the moon's limb, giving for the denominator of the fraction (whereby it is usual to express the mass) 1033. In the later editions of the "Principia" the mean distance of the fourth satellite resulting from Pound's observations, to which allusion is made above, was substituted in the calculation of the mass, which was found to be 1067. (It may here be mentioned that from later observations by Pound with a micrometer on a telescope of 123 feet focus, on the mean distance of the third satellite, Bessel found for the mass 1066). The next attempt in this direction appears to have been made by Triesnecker, Director of the Observatory at Vienna. In 1794 and 1795, making use of a Dollond object-glass micrometer, he obtained a series of measures of distances of all four satellites, the notice of which appears in the Vienna Ephemeris for 1797. Bessel deduced from them, by a mean of the four values, 1055·68. Then follow Bouvard's investigations already mentioned. It is understood that Gauss was the first to bring the perturbations of the minor planets to bear upon the determination of the mass of Jupiter, and that from the perturbations of Pallas he perceived the necessity of an increase to the mass adopted by Laplace. The circumstance, so far as we know, rests upon the authority of Nicolai, who, following in the same steps, discussed observations of Juno at fifteen oppositions, between the year 1804 and 1823, and (in the *Berliner Astronomisches Jahrbuch* for 1826) deduced for Jupiter's mass 1053·92. Encke, from fourteen oppositions of Vesta, between 1807 and 1825, made its value 1050·36, in a paper published by the Berlin Academy of Sciences in 1826.

Sir George Airy's observations at the Cambridge Observatory, alluded to by M. Leverrier in his recent notice, are next in order of time. They were commenced in 1832 and continued till 1836. The final result appears in vol. x. of the Memoirs of the Royal Astronomical Society; it is 1046·77, and depends upon observations on thirty-three nights. Details of the earlier Cambridge observations will be found in vols. vi. and viii. of the same memoirs. Sir George Airy considered it very improbable that there could be an error of a single unit in the denominator of the fraction expressing the mass, being led to this opinion by the close agreement of the separate results.

In the year 1835 Prof. Santini, the present venerable director of the Observatory of Padua, by sixteen nights' measures of the distance of the fourth satellite from both limbs of Jupiter, obtained for the mass 1049·2 (*Ricerche intorno alla Massa di Giove*, Modena, 1836).

Bessel's elaborate series of measures of distances of the four satellites commenced in October 1832 and were completed in the middle of 1839. They are fully discussed in his very valuable memoir, *Bestimmung der Masse des Jupiter*, in vol. ii. of his *Astronomische Untersuchungen:* the definitive value of the mass (p. 64) is 1047·879. Bessel's mass, which has been generally adopted in the calculation of the perturbations of minor planets and comets, and which is so close a confirmation of that deduced by the Astronomer Royal, has received much additional support from recent and, as regards method, essentially different investigations. Thus Krueger, of Helsingfors, from the perturbations of Themis, one of the minor planets which approaches nearest to Jupiter, assigns 1047·16; Axel Möller, by his masterly researches on the motion of Faye's Comet, 1047·79; while Von Asten, from his last investigations relating to Encke's Comet, finds 1047·61.

THE HOPKINS UNIVERSITY, U.S.

THE munificent bequests made by wealthy Americans for the promotion of education in the United States frequently excite our astonishment, for they are unparalleled in Europe at the present time. One of the most unique and well-devised of these bequests has lately occurred. Last year there died a Mr. Jonas Hopkins, a rich citizen of Baltimore, who, after providing for his relatives and leaving various minor benefactions, bestowed the chief part of his estate to found a university with an affiliated medical school and hospital. Both the university and the hospital receive separate landed and other property of such a substantial character that the value of the total amount is over three millions of dollars. Each institution is to be controlled by a board of nine trustees, and the same persons are to be on both boards. The university will have no ecclesiastical or political character or supervision, and will be modelled as far as possible after all that is best in similar American and European institutions. It is intended to give the highest instruction that can be obtained, and the trustees are to act in accordance with the most enlightened experience of the day. The scientific and literary departments will first be organised, and then will follow the departments of Medicine and Law.

No permanent buildings will be erected till all the Faculties are in working order and the wishes of each professor can be carried out; meanwhile a building has temporarily been secured in Baltimore, on the outskirts of which city are the grounds Mr. Hopkins has left for the hospital and university which in future will bear his name. The trustees have already selected the President of the University, and an admirable head they have found in Mr. Henry Gillman, formerly the Principal of the San Francisco University. Mr. Gillman is now in England, maturing his plans and gaining information from various universities in Europe. The dominant wish of the new president is to gather round him a body of professors and lecturers devoted to original research in their different spheres. Only one chair has yet been filled, namely, that of Mathematical Physics, and to this Mr. H. A. Rowland has been appointed. Though still quite a young man, the good work Mr. Rowland has already done in magnetism has made his name well known among English physicists, and in his new position a brilliant career lies before him. It is hoped that students will be received in 1876, and we heartily wish Mr. Gillman every success in his noble work.

SCIENCE IN GERMANY

(*From a German Correspondent.*)

MUCH as may have been written about bone-formation, yet this theme seems still to be inexhaustible, as in the current series of the "Archiv für mikroskopische Anatomie" (of which we gave the contents in a former report) no less than three papers are published on this subject. Two of these, those by Strelzow and by Stieda, speak of the ossification of cartilage and of bone-growth, and arrive at quite contradictory results. The older view on bone-growth starts from the supposition that the bones once formed undergo no further plastic change, that their single parts cannot displace each other, that therefore an insterstitial growth cannot be imagined. If the growing bone, as usual, does not merely show a uniform increase in size, but little by little changes its shape too (the bent bones for instance, the bends of which change during growth), this naturally leads to the supposition that besides the deposit of fresh material, a solution or absorption of those older materials took place, which did not fit the new shape. In opposition to this view, which Stieda also defends, Strelzow tries to prove that the bone grows interstitially, that therefore it can change its shape in an outward direction without reabsorption of any of its parts, that it is useless therefore to suppose the latter to take place, and that there is no reason for such a supposition. Now, with regard to the change from cartilage to bone, it has certainly been proved, for most cases, that the cartilage is first destroyed before in its place a bone grows from fresh materials. But while Stieda thinks this the case everywhere, Strelzow observes that the lower jaw and the shoulder-blade form exceptions to the general rule, the cartilage there passing immediately from its softer state to bone. Hertwig's observations, which he makes with regard to his investigations of the teeth of Reptilia, have a much more extensive range. In Hemibatrachia the teeth form earlier than any other bones of the head, and starting from this basis those bones in the oral cavity are destroyed, which only cover the exterior of the original cartilage skeleton, and are therefore called covering bones. In frogs these bones certainly form without the help of the teeth, which only appear at a later stage; but as frogs (Batrachia) and salamanders (Hemibatrachia) are of the same order, and particularly as the former are the more recent family, Hertwig thinks that in their ancestors the formation of teeth took place in the same way as in the salamanders now, but that in course of time they lost the primitive bone-forming teeth and retained only the bones resulting from them. The formation of teeth now observed in frogs is therefore a secondary phenomenon. Just as the bones of the oral cavity have their origin in the teeth, Hertwig supposes the covering bones on the exterior of the head to result from scales, and states that this is still very evident with certain fishes. What is a rule for lower vertebrata may also be applied to the higher orders, so that *all* covering bones may be derived from scales or teeth, which in sharks and rays are still equivalent and homologous formations. Therefore sharks and rays must be looked upon as the oldest forms of Vertebrata provided with bones; they are succeeded first by salamanders, then by frogs, and finally by the remaining reptiles, birds, and Mammalia.

It is a well-known fact that the gland-cells only absorb certain materials from the blood in order to convey them, more or less changed, into the hollow interior of the gland organ, and thus to furnish useful substances to the organism (secretions), or to remove useless ones from the same (excretions). Wittich demonstrates these relations in a particularly clear manner ("Archiv für mikroskopische Anatomie," 1875). After the injection of differently coloured solutions (carmine ammonia, indigo-sulphate of soda) into the blood of living rabbits, these colours are again excreted by the kidneys. If the animals are killed during this excretion, and the glands are examined, the carmine is only found in the gland vessels, not in their cells; the indigo, however, in the cells also. Such experiments evidently show that the gland-cells have a sort of selective affinity for the two colouring materials, letting the one pass entirely, and partly retaining the other in their interior.

In the same journal Neumann acquaints us with an interesting property of the cells which coat the abdominal cavity of a frog. It is known that some of these cells in female frogs are furnished with cilia, by the motion of which the ova ejected from the ovary into the abdominal cavity are introduced into the openings of the oviduct. Waldeyer, in his book, "Ovary and Ovum," had maintained that as the essential parts of the female genital organs result from the coating of the embryonal abdominal cavity, those ciliated cells physiologically connected with them result from the same basis, viz., the germ-epithelium; while the whole remaining coating of the *later* developed abdominal cavity, with its entirely different physiological signification, must be a formation genetically different from the former. Goette had already proved ("Entwickelungsgeschichte der Unke") that all those formations, together with several others, result from the uniform cell-coating of the abdominal cavity of the embryo. Neumann now specially proves their genetic identity by the observation that these ciliated cells only occur at the time of sexual maturity in the uniform epithelium of the abdominal cavity, and that therefore they represent local transformations of the same. This again confirms the theory, which Goette (*l.c.*) defends for the whole organism, that each embryonal part is not unconditionally intended for certain formations (which has been an accepted belief since Remak), but that from one single and uniform part in the embryo quite different tissues and organs can and may result, solely depending on the locally changing conditions of development. For instance, the coating of the embryonal abdominal cavity, besides the parts already mentioned, also furnishes the fibrous tissue of the intestines, the kidneys, and the heart.

THE LAWS OF STORMS[*]

Recent Criticism and Contrary Theories.—The rules referred to in last article are only empirical and are derived from no theory. Mechanics ought to take them in hand and explain them; but it has not been able to do so, for the circulatory movements of both liquids and gases are as yet a closed letter to that science. They are to-day in the same position as were Kepler's laws before the theory of attraction. Why ellipses? said theorists at the beginning of the seventeenth century. And why put the sun in the common focus of all these ellipses? Are there not also other curves followed by these planets in their course around the sun? But once connected with the principle of universal gravitation, these laws, so neglected by contemporaries, became "the immortal laws of Kepler."

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[*] Continued from p. 403.

Such at present is the position of the Laws of Storms. Despite the adhesion of practical men, meteorologists do not recognise the essential features which *ought*, according to them, to characterise storms. On this account, the practical rules themselves which sailors have followed for thirty years must be rejected; for they are entirely founded, as we have seen, on the circular movement of the air in storms.

These criticisms, more or less direct, based on the theory of centripetal hurricanes or of aspiration, have at the present time all the greater force that mariners themselves have an innate belief in the mere idea of this theory. We even find this belief in the writings of authors who have shown themselves best acquainted with the laws of storms and with the corresponding practical rules. Two examples may be referred to.

The well-known hydrographic engineer, Keller, in his "Treatise on Hurricanes," says that in intertropical regions where cyclones originate, the atmospheric strata underneath the sun dilate and draw up the inferior air of the dilated zone; that if ordinary aspiration, due to the calorific action of the sun, is further promoted by an *electric attraction*, the affluent air will rush with more force into the interior vacuum, &c. Within this space or vacuum he conceives that the water of the sea raised by the central aspiration of a typhoon or a waterspout ascends. When the gyratory column passes from the sea on to the land, it hurls against the shore the water raised by aspiration, and the sea suddenly inundates the low coast to a considerable distance inland. Finally, on land, the force of aspiration of these phenomena exercises its ravages not only by throwing down, but by tearing up trees, and overturning even solid buildings.

M. Bridet, again, asserts that there is formed under the action of the sun, a sort of vacuum resulting from the rapid ascension of masses of heated air. This vacuum is rapidly filled up by the lower currents of air which flow towards it from all directions. These currents, flowing along the surface of the earth, acquire a gyratory motion from the daily rotation. On reaching the base of the ascending column, near the centre of rarefaction, the air carried by these currents gets heated, and expands in its turn; it follows the ascensional movement of the molecules that it replaces, and rises, preserving its rotatory motion.

Persuaded of the reality of this immense draught which the aspiration of ascending columns of heated air must exercise on the lower stratum, in the manner of a chimney, sailors themselves must say that the circular diagram which Reid and Piddington have used for cyclones is scarcely admissible from the theoretic point of view; that already the centripetal movement has been recognised in waterspouts and tornadoes, which, after all, are only cyclones in miniature; that the convergent diagrams proposed recently by Mr. Meldrum, of Mauritius, have perhaps a better foundation, more especially if, as Mr. Meldrum affirms in the cases of two storms which he has recently discussed, these convergent diagrams better represent the true features of the hurricane than concentric circles. Mr. Meldrum's "Note on the form of Cyclones in the Indian Ocean" has been published by the Meteorological Committee of the Royal Society, and is thus well known. We reproduce one of the figures (Fig. 4), and ask the reader to compare it with the circular diagrams of the hurricane in Cuba (Fig. 1); the difference of the two systems will be seen at once.

According to the first the centre is situated perpendicularly to the direction of the wind; according to the second, it will be situated (neglecting for the moment the curvature of the spirals) in that very direction. There is here a difference of nearly 90°.

What will hereafter be the position of sailors in the face of an imminent danger? This is in substance what they are told:—You feel, you see, that a danger menaces you; the aspect of the sky, the state of the sea and of the winds, the steady fall of the barometer, already tell you that there is not a moment to lose if you wish to take the step which may save all. Hitherto you have believed, in the faith of certain empirical rules, that the danger is on your left; not at all—by my theory it is before you.

The captain has no time to search the works of Reid, of Redfield, of Piddington, or to examine the theory of centripetal hurricanes. This is a question which must be quickly answered. Is it necessary, in order to this, to make one's self familiar with all that has been done during the last thirty years in order to *try*, in this repetition of the first investigation, if the centripetal diagrams represent the direction of the wind better than the circular diagrams? This is a labour which would require at least many years.

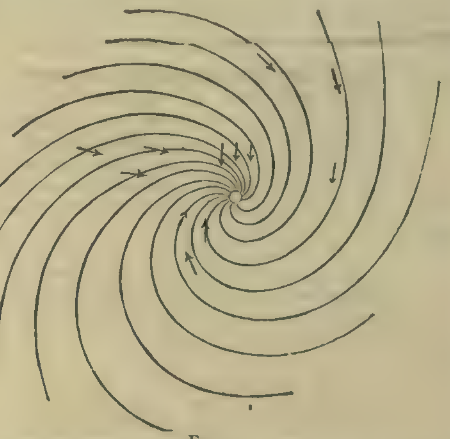

Fig. 4.

Happily there is another method of solving the question, which is to examine that theory of hurricanes of centripetal aspiration which has given rise to all these doubts with regard to the laws of storms. If this theory is found to be true, the authors of the "Laws of Storms" will certainly have been wrong in neglecting its indications. Let us therefore put aside their pretended circulatory movements. The air moves towards a centre of aspiration instead of turning round a point; all will thus be changed, and especially will it be necessary to promulgate practical rules altogether different. But if the theory of aspiration is proved to be false—and, to know what to believe on the subject, long years are not necessary—a rapid examination will be sufficient; if it is false, we say, sailors may continue to place confidence in the rules which have been so serviceable to them for thirty years.

By investigating the whirling movements of which the sun is the theatre, M. Faye was led some time ago to examine this theory without any reference to nautical matters. He has found it completely illusory. On the contrary, that theory which fits into the solar phenomena is found to agree thoroughly with the Laws of Storms; and we need not be astonished at this agreement, for the laws of mechanics are the same everywhere, and the gyratory movements of fluid masses will not vary more in the case of one heavenly body as compared with another than the laws of gravitation. Putting aside solar questions, which interest only astronomers, we shall treat of the purely meteorological question, and in the meantime place before the reader the conclusions of this essay:—

1. The idea of centripetal hurricanes of aspiration originates in an illusion of the sense of sight; it is an old prejudice whose history it is easy to follow from the most remote times to the present day.

2. The theory of centripetal hurricanes, suggested by this prejudice and the hypotheses which it implies, cannot be accepted. The adoption of similar ideas by enlightened minds is only to be explained by the venerable authority of this prejudice.

3. Bases of the mechanical theory of gyratory movements; agreement of that theory with the Laws of Storms. These ought to be considered as a first but excellent approximation; a means of making further advances.

1. *History of a Nautical Prejudice.*—In the midst of the profound calm which often precedes thunderstorms, the lower strata of the atmosphere are not agitated by the least breath; heavy clouds approach at a great speed and cover the sky—a clear proof that powerful currents prevail above, the influence of which does not extend to the ground. From one of these clouds a sort of bag or end of a tube or funnel is seen to issue, and which gradually descends, lengthening at the same time. It seems to be formed of the same material as the cloud; and in fact is a true fog which envelops the cloud, thus rendering it visible to our eyes.

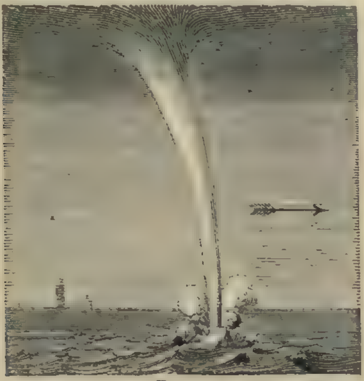

Fig. 5.

Meantime the centre of this funnel is agitated by a violent whirling movement of which the small whirlwinds of dust that are sometimes seen on our roads give a very accurate idea. When the waterspout reaches the ground and encounters obstacles in its way, it sets to work upon these after the manner of a turning machine of great speed at the end of a vertical axis. It raises around its lower extremity a cloud of dust, overturns trees, batters down walls, and unroofs houses. If, instead of land, the waterspout meets with a water surface, it acts upon it like a square-bladed scoop at the end of a vertical axis, and the churned water is thrown to a distance in foam; if it advances on a pool, is empties it in an instant; if on a lake or a sea, the water spurts out all round the foot of the waterspout in clouds of spray.

Look particularly at this long vaporous tube (Fig. 5), which extends from the surface of the earth to the clouds, to a height of from 1,600 to 2,000 feet and upwards; it appears flexible, and has an undulatory movement through its entire length: the least breath of air alters and distorts its form; and its whirling movements are felt down even to its base, which sweeps over the earth, carrying devastation in its train. If it assumes greater dimensions, it is no longer a waterspout, but a tornado. We have here in two words the history of the tornado of Jan. 20, 1854, which occurred in the county of Knox, Ohio, and which in half an hour levelled 50,000 trees with the ground, hewing for itself a pathway through the forest a quarter of a mile broad, which could not have been made in some weeks by a whole army of backwoodsmen.

The tube, which takes the form of a pillar, a funnel, the trunk of an elephant, &c., usually disappears after being as it were broken across, by the violence of its own gyratory movements. Further, the misty vapours which compose it slowly ascend, and the combination of the ascending and whirling motions gives the appearance, when seen at some distance, of a spirally ascending movement, which, however, bears no relation to the internal gyrations of the waterspout. Movements, not real but illusory, are all that are perceived. The spectator supposes he sees objects ascending in the interior of the waterspout. Thus a bit of cloudy vapour looks like a bird caught by the waterspout and rapidly whirled aloft. If the vermicular motion is continuous and along the whole length of the waterspout, the question is asked, what can in this manner ascend in a long tube whose base is plunged into the sea and which violently agitates its surface. At once and without any inquiry the logic of the imagination comes into play, and the conclusion is come to that it is the water of the sea which the waterspout is in quest of; this it pumps up and distributes among the clouds, and its ascent up the tube is plainly seen. No question is put as to how a tube composed of aqueous vapour can hold and sustain deluges of solid water. Moreover, are the clouds not seen rapidly to grow portentously heavier and bigger by the water so abundantly supplied by the waterspout?

It were idle to listen even to observations made under such impressions. For thousands of years sailors have transmitted from age to age tales of waterspouts which have lifted ships into the air, sucked up the water of the sea, and poured it down again on some hapless ship which was unfortunate enough to pass under and break the tube of the spout. Tales like these, unceasingly reproduced with ever-fresh details, powerfully aid the illusion in determining the event before it is seen.

(*To be continued.*)

NOTES

An interesting service to astronomy has been rendered by Mr. Davidson, the head of the American Transit Expedition to Nagasaki, Japan; he has determined the exact site of Abbé Chappe d'Auteroche's Observatory in 1769, when he observed the transit by order of the French Academy of Science, at St. Joseph, California. As Abbé Chappe died soon afterwards from a fever caught while fulfilling his mission, his narration was completed by people who had never been on the spot; a blank has been left in the records of his observations, which has now been filled up 108 years after the event. The Abbé Chappe was an uncle of the celebrated Chappe who invented telegraphs during the wars of the Revolution.

M. Lecocq de Boisbaudran, who is well known in connection with spectroscopic analysis, has just announced the discovery, by means of the spectroscope, of a new chemical element which he calls *gallium* and affirms to be closely allied to zinc. The spectroscopic character of gallium is two violet lines, one corresponding to wave-length 417, and the other to 404, but fainter. The communication was made by M. Wurtz, at Monday's sitting of the French Academy. A commission has been appointed to report on the discovery. Gallium is said to be found in a special blende from Pierrefite mining works, in the Argeles Valley.

It appears that M. Janssen's observatory is to be built at Fontenay at the expense of 80,000 francs. A sum of 50,000 francs is to be spent on instruments, exclusive of the apparatus used in the transit of Venus. He is to have two assistants, each of them receiving 4,000 francs yearly. The instruments are to be under the direct supervision of the Minister of Public Instruction.

METEORS of unusual brilliancy have been seen from several points of late. We recently noticed one seen from the Radcliffe Observatory, Oxford, on Sept. 3, and from the same place we learn that a large meteor was observed on Sept. 7, 11h. 21m. Greenwich mean time, about twice the apparent magnitude of Jupiter, increasing to about four times that of Jupiter, with an accompanying tail of about 5° in length, from near 4 Arietis to a point near *f* Tauri, where it burst into five or six pieces. Colour, blue to green, with red at bursting. Time visible, about seven seconds. It was seen by Mr. Lucas and Mr. Bellamy. Another very peculiar one was seen from Edinburgh and neighbourhood on the 11th inst. A Burntisland correspondent, Mr. G. J. P. Grieve, writes that about 11 P.M. that evening, while pacing a gravel walk in moonlight and partly gaslight, a sudden vivid gleam from behind threw his shadow clear cut on a bright ground. Turning sharp to see the origin of the blaze, after a second or so he noticed a serpentine meteor: the glow or trace left in the path of a shooting star, whose maximum intensity, if not explosion, lay at the west end of the trace. The trace appeared in Auriga, and so close to the three leading stars next south of Capella, that he had not the least difficulty in sketching the position. The particulars are these:—Station in lat. N. 56° 3′ 57″; long. W. 3° 13′ 10″. Position of meteor, in constellation Auriga. Duration from first blaze to disappearance of trace, three to four minutes. Timed at disappearance of trace, 11.2¼ P.M. by Edinburgh gun time. Several letters on this serpentine meteor—"the sky snake" they call it in the north—appear in the *Scotsman*, all agreeing as to its peculiar form and great brilliancy. One observer near Mid Calder "was attracted by the appearance of a magnificent meteor, which was visible for about two seconds, and which, being apparently interrupted in its flight, assumed a zigzag course; and, flashing brightly at each angle thus formed, it disappeared, leaving the snake-shaped track behind it, which was visible for several minutes afterwards, finally disappearing in the form of a ring." On the night of the 14th inst. another magnificent one was visible, apparently over all England. It is noticed in the *Bradford Observer* of the 15th, and Mr. T. W. Shore writes us that he saw it while in the Southampton Water. The time of its appearance, both in the north and south of England, was 8.30 P.M. Mr. Shore, while looking towards the land on the north, observed the meteor commence its luminous course at an apparent altitude of about 30°, and travel to the horizon in a direction from S.E. to N.W. The meteor appeared to him to be about three or four times the brightness of Jupiter, and the time of its course rather more than two seconds. The *Bradford Observer* states that "all accounts agree in saying that it presented the appearance of a flying body of light of considerable size, and that during the period of its passage it lighted the whole sky. It would seem that it first made its appearance from the south-west, its course being over Bowling Park and in a north-westerly direction over Bowling, Horton, and Manningham, and a spectator describes it as an oblong body of light, several feet in length, and bearing the appearance of some solid body in a state of combustion, the sparks flying out on all sides, and a track of flame being left after its passage. Its passage was accompanied by a noise as of a loud explosion, which was plainly heard, not only by those who were outside, but by persons inside the houses who did not see the aërolite itself. All parties concur in saying that so strong a light was cast around that a newspaper could easily be read for the space of half a minute." The same meteor was seen from Manchester and London, and no doubt from various other places. In the report of the meteor of Sept. 3, δ should be λ Piscis Australis.

IN order to stimulate research, experiment, and invention, and to promote the advancement of mining enterprise in Cornwall and Devon, Mr. G. L. Basset, of Tehidy, offers prizes under the following conditions:—1. For the discovery of a new mineral, in Cornwall or Devon, which is deemed likely to become commercially valuable, a prize of 50*l.* An accurate analysis and a description of the leading physical properties and distinguishing characteristics of the mineral to be given, specimens to be handed to the Committee, and the locality and mode of occurrence to be distinctly described. 2. For the invention of a method—mechanical or chemical—of making marketable with commercial advantage, ores or minerals produced in Cornwall or Devon, and hitherto regarded as worthless or of little value. The method to be clearly described, and specimens of the product in its several stages to be handed to the Committee; or, for the discovery of some new application of a mineral substance already known to occur in Cornwall or Devon, either by itself or in combination, to some useful purpose, so as to render it of marketable value, or materially to enhance its value if already marketable to some extent—a prize of 100*l.* The prizes to be awarded at the discretion and according to the judgment of a Committee, consisting of the President and Hon. Sec. of the Miners' Association, and some other gentlemen to be nominated by Mr. Basset. All communications on this subject must be addressed, in the first instance, to Mr. J. H. Collins, F.G.S., hon. sec. of the Miners' Association of Cornwall and Devon, 57, Lemon Street, Truro.

ACCORDING to information communicated to *Aftonbladet* from Christiania, the Norwegian vessel, which in the end of August met Nordenskjöld west of Novaya Zemlya, was the yacht *Elvire Dorothea*, belonging to J. Berger, in Hammerfest. The yacht has returned from the Arctic Sea to Hammerfest. Its master, Johan Alexandersen, states that the Sea of Kara was nearly free of ice, and that it cannot be doubted that Nordenskjöld will reach the goal of his journey, the River Obi.

M. LEVERRIER has announced to the French Academy that Mr. Hind, the superintendent of the *Nautical Almanack*, intends to employ his new Tables of Saturn as soon as they are printed. He reminded the Academy that this will be the sixth table constructed by him that the British Admiralty has introduced into the almanack, and he expressed his sense of the honour thus done him by the Admiralty.

AN interesting and very useful publication comes to us from Germany, under the title of "Die Fortschritte des Darwinismus," by J. W. Spengel (Cologne and Leipzig, E. W. Mayer). This is the second number of the publication, and originally appeared as a paper in Klein's *Revue der Naturwissenschaften*. The purpose of the brochure of eighty pages is to give a brief review of all the works and articles of importance bearing on Darwinism, either *pro* or *con*, published during 1873-4. A very large number of such works, in various languages, is noticed, and their bearing on the Darwinian hypothesis pointed out. The work will be found of great use to those who have not access or have not time to consult all the various publications bearing on the important theory, and will also serve as an excellent bibliography to those who wish to make a thorough study of the subject.

THE German Scientific and Medical Association was opened at Graz on the 17th inst. Lieut. Weyprecht, of the recent Austrian Arctic Expedition, made a speech deprecating all past Arctic expeditions as adventurous and valueless because they constituted an international rivalry that resulted only in giving names to some ice-bound islands. The speaker, amid general applause, expounded a new programme for making Arctic expeditions more fruitful for natural science, and to enable poorer countries to undertake such expeditions.

IN the American *Boston Medical and Surgical Journal* for July there is a paper by Dr. H. P. Bowditch, on the course of the nerve-fibres in the spinal cord. From his experiments the author demonstrates, in opposition to the results of many other investigators, that the channels of motor and sensitive impressions lie in the lateral, and not in the anterior and posterior columns of the cord.

THE International Congress of Physicians was opened at Brussels on Sunday by the King of the Belgians with great ceremony.

IN connection with the Science and Art Department, South Kensington, the following candidates have been successful in obtaining Royal Exhibitions of 50*l.* per annum each for three years, and free admission to the course of instruction at the following institutions:—1. The Royal School of Mines, Jermyn Street, London: John Gray, engineer; Frederick G. Mills, student; Thomas E. Holgate, farmer. 2. The Royal College of Science, Dublin: C. C. Hutchinson, engineer; Henry Hatfield, student; Thomas Whittaker, clerk.

PROF. FLOWER'S important monograph on the structure and affinities of the Musk-deer (*Moschus moschiferus*) has just appeared in the new 3rd part of the Proceedings of the Zoological Society for this year.

WE commend to our readers a paper in Tuesday's *Daily News* on the scientific work of the *Valorous*, by a member of the expedition. Under somewhat trying circumstances much good work was done. Many new and valuable facts bearing upon the very important question of the geographical distribution of particular forms have been added to those already obtained by the *Porcupine* and *Challenger*.

IN a letter in the *Morning Post*, signed "W. S. M.," attention is drawn to the provision in the New Code of the Privy Council Committee of Education for instruction in cooking, house management, &c., in elementary schools, and a very happy suggestion is made. The writer can see no reason why some portions at least of the subject should not at once be introduced into all schools which are in connection with the Science and Art Department. He then shows how very large a number of students attend the classes for Animal Physiology, Organic and Inorganic Chemistry, and Heat, and says: "There is thus already given, though scattered over four subjects, much of the instruction which would belong properly to the special subject of 'Food and its Preparation.' To make the subject an efficient one, all that is needed is to select certain portions from the subjects already taught, 'Physiology,' 'Acoustics, Light, Heat,' 'Inorganic Chemistry,' 'Organic Chemistry;' to group these portions as one subject, and to add to it some additional instruction that is not at all more difficult than much that is already given." We commend "W. S. M.'s" suggestion, indeed the whole of his letter, to the notice of the South Kensington authorities.

THE Cryptogamic Society of Scotland will hold its first Annual Conference at Perth on September 29 and 30, and October 1, the president being Sir T. Moncreiffe, of Moncreiffe, Bart., President of the Perthshire Society of Natural Science, and the secretary, F. Buchanan White, M.D., F.L.S., editor of the *Scottish Naturalist*. The following is the programme of the meeting:—Wednesday, September 29, field-excursions to Moncreiffe, Dupplin, and Scone. Thursday, September 30, (1) Arrangement and examination of specimens; (2) Business meeting (reading of papers and communications, &c.); (3) Fungus dinner. Friday, October 1, show of fungi and other cryptogamic plants in the City Hall, Perth. All fungi, &c., intended for exhibition must be delivered (addressed to the care of the "Keeper of the City Hall, Perth") not later than 10 A.M. on Thursday, September 30. Ferns in pots must be delivered between 8 and 10 A.M. on Friday, October 1. Botanists (especially in distant localities) who purpose attending the conference are requested to give early intimation of their intention, in order to facilitate arrangements. Further information may be obtained on application to the general secretary, Dr. Buchanan White, Rannoch, Perthshire; or the local secretary, Mr. J. Young, C.E., Tay Street, Perth.

A FRENCH blacksmith has devised a perforated plate, put in rotation by clockwork, and intended to place behind the lock of a safe. The consequence is that the safe cannot be opened except at certain times during business hours, when there is no danger of any robber intruding into the offices.

THE patrons of the Lille Catholic University are trying to get an hospital placed at their disposal in order to start a school of medicine, and they have offered a sum of 150,000 francs to the administration of public hospitals in order to have a *clinique* of their own. The answer has not yet been given, but it is doubtful whether the requisition will be complied with.

THE death of M. Duchesne de Boulogne, one of the most celebrated practitioners who engaged themselves in studying medical electricity, took place on Saturday, Sept. 18. M. Duchesne de Boulogne was the author of several cleverly written books on the subject. His death will be felt as a loss by those who are organising the International Exhibition of Electricity, which is to take place only in 1877, having been postponed owing to the amount of work required to collect all the objects relating to that immense science.

THE admirable "Report on the Progress of the Iron and Steel Industries in Foreign Countries," by Mr. David Forbes, F.R.S., has been reprinted in a separate form in the *Journal* of the Iron and Steel Institute.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Kent; a Common Raccoon (*Procyon lotor*) from North America, presented by Mr. W. Binder; a Goffin's Cockatoo (*Cacatua goffini*) from Queensland, presented by Mrs. Barton; an Egyptian Gazelle (*Gazella dorcas*) from Egypt, a Green Monkey (*Cercopithecus callitrichus*) from West Africa, a Brazilian Hangnest (*Icterus jamaicai*) from Brazil, a Sulphury Tyrant Bird (*Pitangus sulphuratus*), two Red-rumped Hangnests (*Cassicus hæmorrhous*), three Blue-bearded Jay (*Cyanocorax cyanopogon*) from South America, deposited; a Getulian Ground Squirrel (*Xerus getulus*) from Morocco, six Houbara Bustards (*Houbara undulata*) from North Africa, purchased; a Wapiti Deer (*Cervus canadensis*), and a Reeves's Muntjac (*Cervulus reevesi*) born in the Gardens.

THE BRITISH ASSOCIATION

REPORTS.

Third Report on the Sub-Wealden Exploration.—Mr. W. Topley made a statement on this subject, embodying the chief points of the report drawn up by Mr. H. Willett and himself. Up to the year 1872 nothing was known as to the beds which lie below the Wealden strata in the south-east of England. The lowest beds exposed were those on the north and north-west of Battle, long worked for limestone. The age of these beds was doubtful, some geologists correlating them with the Purbecks of Dorsetshire, others regarding them as Wealden but of somewhat exceptional character. In 1872, when the Association met at Brighton, Mr. H. Willett proposed to commence a bore hole in these doubtful strata, with a twofold object: (1) to determine the order, thickness, and character of the Secondary rocks below the Weald; (2) to prove the Palæozoic rocks which were supposed to lie beneath at a depth which could be reached. Judging from what is known of the Secondary strata near Boulogne, and comparing them with those exposed in the middle of England, it was hoped that the Palæozoic rocks would be reached at a depth not greater than 1,700 feet from the surface. In August 1874 the boring had reached a depth of 1,030 feet, and was then delayed in consequence of an accident to the rods. This hole was ultimately abandoned, and a new boring was commenced in February 1875, which has been carried to a depth of 1,812 feet. At this point the work has been stopped, in consequence of great difficulties in keeping the hole clear, and it is not proposed to continue the boring further. From the surface down to 175 feet the strata are shales and impure limestones, with gypsum in the lower part. These beds are referred to Purbecks, and with them are now classed the lowest rocks exposed at the surface, formerly called the "Ashburnham Beds." From 175 to 257 feet the strata are chiefly sand and sandstones; these are held to represent the Portland Beds. Below 257 feet there is a great series of bituminous shales and clays, with occasional bands of cement stone and sandstone. Kimmeridge Clay fossils extend down to 1,656 feet at least, possibly lower; so that this formation is here at least 1,400 feet thick. The bottom beds of the boring, just reached, are oolitic in structure, and contain bands of hard limestone. To this extent, then, the Secondary rocks have been traversed, and their order and structure ascertained. A discovery of some commercial value has been made, for two companies are in existence to work the gypsum. One of these has been for some time in operation; a shaft has been sunk and the mineral is now being raised. Scarcely less important is the knowledge now attained that no supply of water can be got by deep wells or borings into the Sub-Wealden strata. As regards the Palæozoic rocks, the boring has not had the success that was anticipated. The Secondary strata have proved too thick, and there is little or no hope of reaching the older rocks here. A boring is now in progress at Cross Ness by the Metropolitan Board of Works; this will be carried through the gault, and may possibly throw some light on this question.

Report of the Committee on Erratic Blocks, by the Rev. H. W. Crosskey.—The Committee continue their record, without attempting the more ambitious task of connecting the facts they report with theories of the history of the Glacial epoch. It will be observed, however, (1) that the facts reported increase our knowledge of the area over which erratic blocks are distributed; (2) that the boulders are connected together in more definite groups, distinctly pointing to special centres of distribution; (3) that the possibilities are increasing of obtaining a more exact history of the periods into which the great Glacial epoch must be divided from the grouping and distribution of erratic blocks. Boulders and scratched stones are reported in South Devonshire. New Red Sandstone boulders occur on the left bank of the River Dart, at Waddeton, the largest measuring 6 × 3 feet, at elevations extending from 15 to 200 feet. Are they travelled masses? If so, whence did they come? When were they lodged where they now lie? What was the agent of transportation? The boulders may have been remnants of New Red beds which once covered the older formations now exclusively overlying the district; but the different levels at which they are found, the present configuration of the surface of the country, and the great weight of some of them, indicate the possibility of their having been transported by ice from some part of the district lying between Berry Head and Galmpton Common. At Englebourne scratched blocks occur of fine grained trap over an area having slate as its subsoil. Although the size of these boulders renders their mobility under the action of waves possible, yet the grooves upon them appear to indicate ice action with considerable distinctness. A group of small boulders of mountain limestone have been found in the north-east of Hertfordshire, 100 miles from their source in Derbyshire. In Nottinghamshire remarkable boulders have been exposed by a new railway cutting, many of them finely striated, which have been described for the Committee by the Rev. A. Irving. The boulders are of lias, millstone grit, and carboniferous limestone. The boulders of lias limestone are derived from the liassic strata of the immediate neighbourhood upon which they chiefly lie. The nearest millstone grit is formed at Castle Donnington and Stanton-by-Dale in Derbyshire, on opposite sides of the Trent Valley; the former place twelve miles south of west, the latter twelve miles north of west from the deposits in which they occur. The nearest carboniferous limestone corresponding to that of the boulders is found at Ticknall in Derbyshire, about eighteen miles distant south of west. The height of the group above the sea is about 200 feet. The extent of the boulder clay and deposit is at least several square miles. In the cutting between Plumtree and Stanton the boulders are largest and most numerous, and are mingled with an immense number of quartzite pebbles, the whole being compactly bound together. In Leicestershire, there is no doubt, Charnwood Forest was a centre of distribution by ice, of blocks of all sizes. The position of various boulders is reported seven miles from their source, together with a block of peculiar millstone grit, at Hoby, near Melton, which must have come from Durham or Northumberland. In Worcestershire (Bromsgrove district) ninety-three boulders have been examined, many of them of considerable size, consisting chiefly of varieties of felspathic rock. It is impossible as yet to generalise on their distribution, but it is noticeable that no specimens of granite have been observed in this district, although they occur so abundantly around Wolverhampton. A list is given of the size and position of the principal erratic blocks, which are rapidly being destroyed. The group of felspathic boulders extends through Northfield and King's Norton to Birmingham. Isolated, and in many cases striated, boulders are reported in the neighbourhood of Liverpool, including blocks of greenstone, syenite, felspathic ash, &c. On the north-west of Bradford a few boulders are reported, similar to the rocks at Scaw Fell, Cumberland, and containing small garnets. The destruction of erratic rocks is going on so rapidly through the country that the Committee earnestly request that reports may be forwarded to them of their occurrence. Some are being buried to get them out of the way of the farmers; others are built into walls, made the foundations of houses, or blasted into fragments. In some cases they constitute the foundations of church towers. A timely record will preserve many facts of large import and assistance in the discussion of problems connected with the centres of ice action, the range of the land ice, the courses of icebergs, and the existence of interglacial epochs.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS AND PHYSICS

On the Measurement of Wave Motion, by Prof. Frederick Guthrie.—The rate of progression of a wave in a liquid of infinite depth and extent depends upon the wave length; scarcely at all upon its height, and not at all upon either its breadth or the density of the liquid. The measurement of rate of wave-progression in open water is difficult and at best inaccurate. Natural waves generated and supported or restrained by wind have abnormal rates of travelling. Artificial waves in ponds degenerate rapidly in height and increase in wave length, and so in wave progress-rate. The time required by a wave generated in the middle of a pond in reaching the edge, is dependent on its mean wave length. Perhaps after reflexion from the edge the conditions are sequentially reversed, and the time occupied in returning is equal to that of departure. Perhaps not. I think not, because the increase of wave length (and therefore of wave progress) is a function of the height. Be this as it may, many sources of error are got rid of by using troughs of limited surface and indefinitely great depth, by causing the original and reflected wave so to interfere as to produce one or more nodes; and instead of measuring the time required for the crest of a wave to travel in a straight line over a given distance, by measuring the number of times the crest of the wave system reappears in the same place in a given time; in other words, by transferring to liquid waves the method used to measure the rate of sound in solid bodies. As far as the method is trustworthy we get by means of a trough whose diameter is one or two feet, a more accurate method of measuring the rate of wave progress than by an experiment in an ideal pond a mile across.

Experiment shows that if a concentric binodal wave system be generated in a cylindrical trough of water of more than a certain depth (say half its diameter), the following conditions hold good. A nodal ring is formed at one-sixth of the diameter from the circumference. The amplitude at the centre is double that at the circumference unless the disturbance is very great. The rate of undulation—that is, the number of times in a given time that the crest appears in the centre—does not depend sensibly upon the amplitude, nor upon the temperature, nor upon the density of the liquid. It depends almost wholly upon the wave length of the waves formed—that is, upon the diameter of the trough—and is identical with the number of beats of a pendulum whose length is equal to the radius of the trough. Hence the rate of undulation varies inversely as the square root of the trough radius or diameter. This confirms the assertion that the rate of wave-progress varies directly as the square root of the wave length; because the rate of recurrence must vary as the rate of progression divided by the path.

Experiment shows that a wave of 1 meter wave length would travel 83·07 meters in one minute if it did not alter its wave length, and moved automatically. A cylindrical trough of water more than, say, 500 millimeters deep and 1·988 meters in diameter, will, in the latitude of London, undulate in seconds, and will remain isochronous with the London seconds' pendulum wherever they travel together.

In rectangular troughs, the wave progress is hindered. The rates of recurrence of phase in rectangular troughs are slower than in circular troughs when the wave lengths are the same; and this difference is greater when the wave length is greater. Both circular and rectangular troughs accept mononodal undulation. The rate of progress between parallel walls of a wave 1 meter long is found to be 74·7, and this is independent of the distance of the walls apart. The mononodal undulations in circular and rectangular troughs have also been examined.

The comparative empirical mean constants in minute-millimeters are—

	Circular.			Rectangular.	
	Mononodal.	Binodal.		Mononodal.	Binodal.
	(*a*)	(*b*)		(*c*)	(*d*)
$n\sqrt{d}$ =	1762·56	2613·24;	$n\sqrt{e}$ =	1594·16	2360·04.

where d is the diameter of the circular trough and e the length of the rectangular one.

The water in a circular trough can also undulate with two perpendicular rectilinear nodes.

Taking the same trough, it is found that the number of undulations per minute, when (*a*) the circular binodal, (*b*) the mononodal, and (*c*) the binodal rectangular systems were established, were—

$$a = 106·9 \qquad b = 71·6 \qquad c = 94.$$

These numbers a and c agree well in ratio with those of a circular elastic plate in similar vibration. The details of this communication were laid before the Physical Society in June last. They will, I hope, appear in part in the *Philosophical Magazine* for October.

SECTION B—CHEMICAL SCIENCE

Prof. Cayley read a paper *On the Analytical Forms called Trees, with application to the theory of chemical combinations*, before a good audience composed to a considerable extent of mathematicians.

The author in commencing stated that the subject he was about to consider was more mathematical than chemical, but as the results bore considerably upon the latter subject he had introduced it in this Section. The problem to be solved was to find the theoretic number of the hydrocarbons C_nH_{2n+2}.

The only assumptions are that an atom of hydrogen can link itself to one other atom, and an atom of carbon to four other atoms. A combination of n carbon atoms can then link itself on to 2_n+_2 hydrogen atoms at most, but this number is only attained when the carbon atoms are linked together without cycles, or so as to form a "tree": given the tree, the hydrogen atoms can be linked on in one way only, and the question thus is to find the number of trees which can be formed with n carbon atoms. The atoms, or dots representing them, are termed "knots," the lines joining two knots are termed "branches"—the trees in question are such that from each knot there proceed at most four branches; but this limitation is in the first instance disregarded. A tree may be considered as springing from any one of its knots as its root, and trees which are chemically the same thus present themselves under different forms. For the treatment of the chemically distinct forms it is necessary to introduce the notions of a "centre" and a "bicentre" (due to Prof. Sylvester); and the question is reduced to that of finding the number of the *central* trees with n knots: this is solved by the method of generating functions, viz., the number of the central trees of altitude N is given by a series of the form—

$$t\,x^{N+1} + \{t, t^2\}x^{N+2} + \{t, t^2, t^3\}x^{N+3} +, \&c.$$

where the numerical coefficient of any term $t^{\alpha}x^{N+\beta}$ shows the number of trees of α main branches and $N+\beta$ knots. The final result as regards the carbon-trees, or say the hydrocarbons C_nH_{2n+2} is given by the following table:—

n =	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11,	12,	13
Central ……	1,	0,	1,	1,	2,	2,	6,	9,	20,	37,	86,	183,	419
Bi-central …..	0,	1,	0,	1,	1,	3,	3,	9,	15,	38,	73,	174,	380
Total ……	1,	1,	1,	2,	3,	5,	9,	18,	35,	75,	159,	357,	799

so that theoretically for the body whose formula is $C_{13}H_{28}$ there exist 799 isomeric bodies.

It is worthy of remark that the mathematical theory agrees with experiments for the first five bodies, thus affording strong confirmation of the truth of the remainder.

The Professor also drew attention to the fact that any number is sometimes rather more and sometimes rather less than double the preceding number.

Prof. Armstrong suggested that probably a large number of these isomers would be unstable, illustrating his meaning by the two isomeric di-nitro-phenols, one whose melting-point was 76° C. readily passing into the other whose melting-point was 116° C., which was objected to on the ground that it was not fair to compare the action of bodies as complicated as the phenols with the simple hydrocarbons.

Prof. Clifford also made some remarks on the bodies represented by $C_nH_{2n+2-2x}$, and stated that it would be found that x represented the number of cycles that would occur in the trees.

Mr. P. Braham made some remarks on some further experiments on *Crystallisation of Metals by Electricity*, in which he stated that he had placed the positive and negative electrodes of a battery in a vessel containing a mixed solution of copper and zinc, and that with terminals of copper he obtained a dull crystallisation proceeding from the negative pole of mixed crystals of copper and zinc, and beyond this, crystals of copper alone. With terminals of zinc he got a mixture of crystals as before, and in front of these, crystals of zinc alone. But if terminals of brass (a compound of zinc and copper) are used, there is a dull crystallisation of zinc across the field. He also observed that with zinc terminals, by increasing the battery power, the crystallisation is broken up; but not so when the terminals are copper or brass, but then the crystallisation extends above and beyond the positive pole.

Mr. Gatehouse read a paper *On Silver Nitrite*, giving the results of some investigations into the causes of what is termed by photographers "woolliness" in their negative baths.

The five methods given of preparing the nitrite were as follows:—

1. By mixing solutions of potassium nitrite and silver nitrate.
2. By sensitising a collodion film and evaporating to dryness a mixture of nitrite and nitrate is obtained.
3. By fusing silver nitrate with organic matter.
4. By electrolysis of silver nitrate with platinum electrode.
5. By means of metals placed in neutral solution of silver nitrate.

By this last method he found that metals which produced reduction, viz., K, Na, Bi, Hg, As, Th, did not produce nitrite, but those which did not produce reduction, viz., Fe, Ni, Co, Mg, Zn, Cu, Pb, Sn, Sb, did produce nitrite. The former, it was observed, have an uneven equivalency, and the latter an even equivalency, with the exception of Hg and Sb, the latter of which may, like Fe, be tetratomic. The physical forms of the crystals were observed to vary from modular masses to filiform crystals.

Mr. A. H. Allen, in making some remarks *On a Method of effecting the Solution of difficultly-soluble Substances*, stated that he had found that many so-called insoluble substances could, when heated with fuming hydrochloric acid in sealed combustion tubes, be either completely dissolved or decomposed with separation of silica. In some cases where hydrochloric acid failed, sulphuric acid succeeded. The heating of the tubes was generally done by means of a water bath, but for some substances a chloride of calcium bath must be used.

Mr. J. C. Melliss read an account of the method of purification of a river by precipitation, at present adopted at Coventry. He stated that 2,000,000 gallons of sewage liquor, contaminated by dye, refuse, &c., were daily passed through these works and completely purified. The process employed is briefly the following:—The water of the river, after being mechanically strained from solid impurities, is passed into tanks, where it is mixed with sulphate of alumina; it is then passed to a second set of tanks where it is mixed with milk of lime, and thence on to a field or filter bed 4½ acres in extent, which ejects 80,000 gallons of water per hour, pure enough for fish to live in. The greatest difficulty to be contended with was the freeing of the precipitated matter from the water, of which it contained 80 per cent.; this quantity, however, was considerably reduced by means of mechanical appliances, which reduced the water to such a percentage that it could either be dried (and so rendered portable) by heat, or by mixing it with some substance which increased its manurial value. In conclusion, the author stated that the primary object was to secure sanitary rather than commercial success, and that this certainly had been achieved at a cost of about sixpence per head per annum for a population of 40,000.—Some discussion ensued as to the relative merits of the method of irrigation and the method just described.—In reply, Mr. Melliss said that he was not prepared to say that the Coventry method was the best in all localities; the physical characteristics of the land in neighbourhood must always be taken into account, as of course it would make a great difference whether the soil consisted of clay or of sand.

Prof. Debus read a paper *On the chemical theory of Gunpowder*, in which he stated that nothing illustrated in so striking a manner the molecular changes produced by chemical action as the explosion of gunpowder. He said that some years ago the eminent French chemist Berthelot showed that if CO_2 be passed into a mixture of BaO and CaO in insufficient quantity to precipitate the whole of the barium and calcium as carbonate, then neither is the whole of the barium precipitated nor the whole of the calcium, but they are precipitated in a certain definite proportion, which is a multiple of their molecular weights. Hence, in general, if a mixture of the salts A and B be decomposed by some other substance, C, in insufficient quantity to decompose the whole of both, then the bodies formed will be $AC_1 + BC_2$ where $C_1 + C_2 = C$; and moreover, if the quantity of B is doubled or trebled, &c., the quantity C_2 will be increased in a definite proportion. After making some further remarks of a like nature on the decomposition of a mixture of $BaCl_2$ and $CaCl_2$ by CO_2, and also of the explosion of mixture of H and CO with an insufficient supply of oxygen (as investigated by Bunsen), the Professor went on to show that the same arguments might be applied to the explosion of gunpowder which was a mixture of carbon, sulphur, and nitrate of potash.

He then placed upon the black board the result of one of a large number of analyses of one grain of powder.

Compound.	Grain.	
(1) K_2CO_3	·3098	·00224
(2) $K_2S_2O_3$	·0338	·000177
(3) K_2SO_4	·0658	·000378
(4) K_2S	·1055	·00096
(5) CO	·0473	·00170
(6) CO_2	·2770	·0629 *

In addition to these were also formed in *small* quantities the following: potassium sulphocyanide, potassium nitrate, ammonium carbonate, sulphur, sulphuretted hydrogen, marsh gas, hydrogen, and nitrogen, most of which appear to have been the result of gaseous impurities in the carbon.

Referring to the table it will be seen that by adding up the total molecular value of the sulphur salts we get ·00151, which bears to the molecular weight of potassium carbonate (·00224) the ratio 2 : 3 nearly. Hence it is inferred that at the first moment of combustion the potassium in the saltpetre divides itself into five parts, two of which go to unite with the sulphur, and three to form the carbonate. Again, it will be seen that the carbonic oxide bears to the potassium very nearly the simple ratio 3 : 4. The CO_2 must have been formed in more than one reaction, because it does not give any simple molecular ratio. The conclusions thus arrived at are, that in the first moment of explosion the sulphur existed either as sulphite or as sulphate, and that the carbonic oxide must have been formed simultaneously with the potassium carbonate. The equations of the decomposition of gunpowder would then be the following:—

(1) $24KNO_3 + C_{35} + O = 12K_2CO_3 + 9CO_3 + 14CO_2 + 12N_2$
(2) $16KNO_3 + C_8 + S_8 = 8K_2SO_4 + 8CO_2 + 8N_2$
(3) $6K_2SO_4 + C_{11} + S + O = 5K_2S + K_2S_2O_3 + 11CO_2$.

The first two reactions taking place simultaneously.

Prof. Thorpe, in giving some account of a *New Compound of Fluorine and Phosphorus*, said that having had some occasion recently to make a considerable quantity of the terfluoride of arsenic, by heating calcium fluoride with arsenious acid in the presence of Nordhausen sulphuric acid, he was induced to study the behaviour of this body with various other substances. When this terfluoride of arsenic is dropped into a solution of the pentachloride of phosphorus, such an immense amount of heat is evolved that it is necessary to keep the vessel surrounded with a freezing mixture, and dense white fumes are given off, while only chloride of arsenic remains in the solution. This gas is decomposed by water, but may easily be collected over dry mercury, in which condition it may be kept, but after some time the glass is observed to become dim. The specific gravity of the gas answers to the formula PF_5, and its molecular weight is 63. It acts readily upon alcohol, but the substance formed quickly corrodes glass. It is believed that it will be found to be a condensable gas under a pressure of six or seven atmospheres. It is not impossible that when decomposed by the electric spark it may give *fluorine*. It is remarkable as the only known pentatomic compound of phosphorus.

Mr. B. J. Fairley, F.R.S.E., read a paper *On New Solvents for Gold, Silver, Platinum, &c., with explanation of so-called Catalytic Action of these Metals and their Salts on Hydrogen Dioxide*, in which he stated that it was perfectly easy to dissolve silver in dilute acids, as acetic, sulphuric, or hydrochloric, provided hydrogen dioxide were present in the solution, and that if under the same circumstances the silver were dissolved in nitric acid no lower oxides were evolved. Repeating the experiments with gold, it was found that acetic and nitric acids scarcely dissolved it at all, but hydrochloric acid readily, and without the evolution of free chlorine. Some remarks were also made on the great liberation of heat observed when two unstable compounds of oxygen react upon one another so as to produce more stable compounds, especially with reference to the heat evolved during the decomposition of ozone and hydrogen dioxide, the author stating that this great *heat* must correspond to a great *force* of union.

The same gentleman also made some remarks *On the Use of Potassium Dichromate in Grove's and Bunsen's Batteries to ensure constancy*, in which he stated that he had used a small quantity of that substance dissolved in the nitric acid, and had found that the battery remained constant so long as any chromic acid remained to be reduced, and that no red fumes appeared.

Two other papers were also communicated by the same author: (1) *On a New Process for the separation of Lead, Silver, and Mercury (Mercurous) Salts*; (2) *On a Process for the Preparation of Periodates, with their application as a Test for Iodine and Sodium.*

Dr. J. H. Gladstone read a paper *On the relation of the Acids and Bases in a mixture of Salts to the original manner of combination.* In a former set of experiments the author had shown that if a molecule of copper nitrate and a molecule of potassium sulphate be dissolved in any quantity of water, and two molecules of potassium nitrate with one molecule of copper sulphate be dissolved in an equal quantity of water, then the colour produced is the same: and similarly for other sets of salts. The author, however, thought that the colours of these mixtures being comparatively faint, it would be better to try mixtures of colourless salts, and add to these mixtures some substance such as ferric sulpho-cyanide, ferric mæconate, or bromide of gold, whose colour is easily reduced. Accordingly, he mixed together potassium sulphate and magnesium nitrate, and the corresponding salts potassium nitrate and magnesium sulphate; also acetate of potassium and nitrate of lead, and the corresponding salts, &c.; in every case these were found to reduce the colour of ferric sulpho-cyanide equally. All the experiments united to confirm the supposition that the effect of a mixture does not depend upon the position of the acids and bases in it, so long as the proportions of each remain the same.

Dr. Russell asked if the amount of colour would indicate a small change in the nitrate, and also if the element *time* had been taken into the experiments.

Dr. Tilden preferred the old method, on the ground that by adding a reagent new conditions are introduced.

In reply, Dr. Gladstone said that the ferric sulpho-cyanide was much more delicate than the solutions of copper salts.

Dr. J. H. Gladstone read two notes, *On the Copper-Zinc Couple*, by himself and Mr. Alfred Tribe. In the first he showed that whereas a piece of zinc in dilute sulphuric acid (3½ in 1,000 parts of water) gave off seven volumes of hydrogen in one hour, the same piece of zinc, when covered with spongy copper, gave off eighty volumes in one hour, which showed an elevenfold increase for an addition of the negative element of only 0·11 per cent. In the second note he showed that if a quantity of arsenical zinc foil was "coupled," washed and heated with water, and two litres of hydrogen evolved therefrom were passed through a tube heated to redness, not a trace of arsenic was observed; but when a portion of the same arsenical zinc was treated with dilute sulphuric acid, and two litres of hydrogen evolved by the action were passed through a heated tube as before, ·0019 gramme of arsenic was deposited in the cool part of the tube. Arsenical zinc, when covered with spongy copper and acted upon with dilute sulphuric acid, also gave arseniuretted hydrogen. This appears to show that it is not the copper, but the inability of the arsenic to get into solution when hydrogen is made from water and the "couple," which is confirmed by adding an aqueous solution of arsenic to the same couple, when the mirror immediately appears.

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* The third column is the number found by dividing each quantity by the corresponding molecular weight.

The same gentleman also read a paper by the same authors, in which it was shown that if aluminium be "coupled" with more negative metals, such as copper or platinum, then at the ordinary temperature of the air in the latter case, 4 c.c. of hydrogen are evolved in twenty-two hours, and if the temperature be raised to 100° C., in the first six hours 484 c.c. are evolved. Aluminium alone, according to Deville, only decomposes water at a white heat.

The President read a paper *On an apparatus for estimating Carbon Bisulphide in Coal Gas.* The principle upon which the success of the method depends is the following:—When carbon bisulphide is heated in the presence of hydrogen, sulphuretted hydrogen is formed.

The apparatus consists of a flask filled with pebbles and asbestos (to expose a large surface to the action of heat), and surrounded by fire-clay cylinders, in which gas is kept burning. This flask is connected through a solution of lead with an aspirator. There are other connections also by means of which gas from the source requiring to be tested circulates through the flask and is burnt. When the flask has been heated for about twenty-four hours continuously (to expel all moisture), a measured quantity of water is drawn off from the aspirator, which causes the same volume of gas to bubble through the lead solution, and on account of the presence of sulphuretted hydrogen to produce a decolorisation of the lead solution. A similar vessel containing the same quantity of lead solution and a *known* quantity of sulphuretted hydrogen is placed beside it, the gas being allowed to bubble through the first until the colour is judged to be equally intense; the amount of sulphuretted hydrogen in a known volume of the gas is thus found, and hence the amount of carbon bisulphide. Having once got the apparatus started, gases from several different sources may be tested.

Prof. A. Oppenheim made some remarks on *oxyuvitic acid*, which he stated belonged to the aromatic series, and said he was able to show that it could be prepared from its elements, thus making the fifth of that series which could be prepared by synthesis. The formula of the acid he showed to be $C_6H_2\left\{\begin{matrix}CH_3\\OH\\COOH\\COOH\end{matrix}\right.$ thus making it a derivative of benzole. It gives a reddish brown colour with ferric chloride in the presence of alcohol. If it is slightly heated it changes its composition to $C_6H_3\left\{\begin{matrix}CH_3\\OH\\COOH\end{matrix}\right.$ which gives a violet colour under the same circumstance: if it is still further heated it is converted into $C_6H_4\left\{\begin{matrix}CH_3\\OH\end{matrix}\right.$ or cresole.

The Professor also made some remarks on the derivatives of mercaptan, which were founded on some researches of Dr. Williamson on the action of chloroform.

Mr. Chas. T. Kingzett read a paper *On the Oxidation of Essential Oils*, which he observed was a continuation of papers which had previously been communicated to the Chemical Society. The object of the paper was to give some results on the limited oxidation (by air) of terpenes of the general formula $C_{10}H_{16}$, certain terpenes of the formula $C_{15}H_{24}$, and cymene, $C_{10}H_{14}$. The terpenes experimented upon were hesperidine, myristicene (obtained in three different ways from oil of nutmeg), wormwood, all of which gave on atmospheric oxidation, peroxide of hydrogen and acetic acid. Citronella and Ylang Ylang, clove-terpene ($C_{15}H_{24}$), were found to develop no peroxide of hydrogen. Cymene obtained from three sources and exposed to atmospheric oxidation was also found to develop peroxide of hydrogen. These researches prove that in terpenes of the formula $C_{15}H_{24}$ the carbon exists in an allotropic form.

SECTION D—Biology

Department of Anthropology.

One day was chiefly occupied by a valuable series of papers on the population of the Indian region. A combined discussion on the three papers now to be noticed followed their reading. The first paper was by Sir Walter Elliot, *On the original localities of races forming the present population of India.* After some preliminary remarks, he said that the circumstance of colour was one of the most observable signs of difference of race, and the very word for the Aryan institution of caste was *varanum*, or colour, they having doubtless introduced it to distinguish themselves from the Dasyns or alien peoples with whom they came in contact on crossing the Indus. The author detailed the different colours or races now inhabiting India, and went on to remark that it is now generally admitted that the centre of dispersion from which all the peoples of the earth had migrated was Central Asia. The first great wave that surmounted the Himalayan barrier, at a time when the earth's surface was in a different condition from what it is now, could no longer be traced as a separate and distinct people. Remnants of the primeval movement were now only to be found amongst the most degraded denizens of the hills and forests, and probably in the despised slave population. The great Dravidian migration must have been made much later in time. It was probably not a simultaneous movement, but consisted of successive swarms, which would account for the existence of well-defined groups among them, which had preserved their characteristics unchanged to the present day.

But the normal representatives of the race were to be found in the mountaineers of Central India, where, protected by regions of deadly malaria encircling their highland territory, they have for ages bid defiance to hostile aggression, and preserved their habits and independence unchanged. The ground on which so many at first sight heterogeneous races were united under the title of Dravidian was mainly community of language, but that test was not infallible. A better link was furnished by similarity of form, features, colour, and structural coincidence. He maintained that the characters of Prof. Huxley's Australioid type could be traced among the classes of Dravidians, modified as was to be expected, among those most exposed to external influences, but still always apparent to a practised eye. There was nothing to show by what routes the first settlers arrived. Their advance was probably a slow and gradual percolation from different parts of the north through the mountain barrier that cuts off India from the rest of Asia. The migratory instincts or necessities of the people of Central Asia exerted themselves in all directions. Of the exact seat of the brown-skinned, wavy-haired Australioids, they had no definite knowledge. But the Mongols and Mandchurians sent off successive hordes to the south-east, whence in time the teeming population of China sought an eastern direction. Those people were thus brought into contact with tribes already settled there from a more westerly quarter. Thus the inhabitants of Siam, Burmah, and the Malayan Peninsula, spoke a monosyllabic language, but wrote it in a Dravidian character, and Mr. Hodgson found the scattered tribes around Nepaul partaking of the same mixed characters, both with regard to race and language.

Mr. Hyde Clarke's paper *On the Himalayan Origin of the Magyar and Fin Languages*, attempted to prove his theory by facts of analogy in the languages themselves, and by inferences from facts of history. He found that the affinities of Magyar and Fin were strongest for the languages of East Nepaul.

Mr. Bertram Hartshorne, of the Ceylon Civil Service, read a paper on the interesting *Weddas of Ceylon*, who still depend for their means of subsistence upon their bows and arrows, and pass their lives in the vast forests of Ceylon without any dwelling-houses or system of cultivation. There is an entire absence of any flint or stone implements among them, and their state of barbarism is indicated by the practice of producing fire by means of rubbing two sticks together, as well as by their habitual disregard of any sort of ablution. Their intellectual capacity is very slight; they are quite unable to count, or to discriminate between the colours; but while their moral notions lead them to regard theft or lying as an inconceivable wrong, they are devoid of any sentiment of religion except in so far as that may be inferred from their practice of offering a sacrifice to the spirit of one of their fellows immediately after his decease, their idea of a future state being that they become devils after death. They never laugh, and they are very noteworthy as being the only savage race in existence speaking an Aryan language. Their vocabulary consists largely of words derived directly from the Singhalese; others indicated an affinity with Pali or Sanskrit, whilst there remained a considerable residue of doubtful origin. There was an absence of any distinctly Dravidian element.

In the discussion on these papers, Prof. Rolleston said that the ethnology and languages of Hindostan were now in pretty much the same state of fusion as those of Great Britain. Since the writings of Sir George Campbell and others, and the excellent publications of the Indian Government, he had arrived at the conclusion that the Australioid and not the Mongolian type was that which formed the substratum all through the outcast tribes of India: this accorded also with the probabilities of evolution. He believed that the earliest races of mankind were eminently Australioid, with long and narrow heads. With regard to the Weddas, it was a most interesting question whether they were really a degraded outcast Sanskrit population. Max Müller was of that opinion; and their possession of the bow and arrow, which no Australioid ever had, tended in that direction. Their skulls were not Australioid.—Sir George Campbell did not know that there was any authentic case of degradation of a race. In this instance the *primâ facie* inference seemed to him to be that the Weddas were an aboriginal race. Very small tribes which had been reduced in numbers easily changed their language under the influence of a more powerful surrounding people. From the photographs of the Weddas he pronounced their absolute identity in feature with many of the barbarous aboriginal tribes of India which he had seen, and which were distinctly non-Aryan. The use of the bow was universally known among the aboriginal races of India, which had the same notions about witchcraft, &c. as the Weddas. He asked for information as to their strength in the left arm, which Mr. Hartshorne had mentioned, for he had always supposed that the use of the bow called forth strength in the right arm.—Mr. Hartshorne said that in his experience of shooting with the bow, he had found that the great tension in pulling the bow was on the muscles of the left fore-arm. He was therefore prepared to find that the Weddas were stronger in the left arm, and it was so.—Sir Walter Elliot agreed with Sir G. Campbell as to the aboriginal character of the Weddas, but believed in the possibility of great degradation.—Mr. Hyde Clarke said they had all the appearance of being an aboriginal people. Their speaking an Aryan language was no decisive reason for calling them Aryans.

Dr. Leitner gave a graphic summary of the results of his travels and researches in the Central Asian region to which he has given the name Dardistan. He gave the following as the chief results of his investigations:—"First, we have ascertained the existence of a number of languages—one of which, Chilasi, the object of my mission, is a mere rude dialect—which were spoken at or before the time that Sanskrit became the 'perfect' language, for no one who can speak any of the derivative languages of India can class the bulk of the Dard languages among them. Secondly, the legends and traditions of the Dards show a more European tone and form than anything we find in India. Thirdly, by the adoption of the term Dardistan for the countries between Kabul, Kashmir, and Badakshan, we are driven to compare a number of races which offer certain analogies, and which may have a certain history in common since the time of Alexander the Great's invasion of India. Fourthly, our Government now know accurately what they certainly did not know before 1866, the modern history of the countries bordering on Kashmir." He found that the dialects in this district, which were in a highly inflexional state, had been preserved from deterioration by isolation and other causes. He had very little doubt that Dardistan was the first halting-place of the Aryan migration to India; the second being Kashmir. There was as great a difference among some of their dialects as between French and Italian. They had songs, legends, and fables of superior character, which he had carefully taken down and would publish. Among the evidences of their high state of civilisation were the respect shown to the female sex, and the liberty and responsibility accorded to them; their love and charity to animals; and the charm and beauty of their legends. They called themselves the brethren of the Europeans. Associated with them was a race of predatory kidnappers, very similar to them, but speaking a somewhat different language. He had found a great quantity of art products, especially sculptures, which clearly indicated a great influence of Greece upon them in very early times, probably through the existence of the Bactrian kingdom. There was no trace of the later and more extravagant influences of Buddhism, but scenes essentially Buddhistic and Asian were treated after the Greek manner, and very much with the Greek success. Expression attained a high level in these works.

Prof. Rolleston read a paper *On the Applicability of Historical Evidence to Ethnological Inquiries*, in which he showed the danger of drawing conclusions from isolated expressions of historians unless they were of the first class, such as Cæsar and Tacitus. He quoted modern examples of carelessness and inaccuracy in this respect. He referred especially to the Cimbri, who were dealt with in the next paper, and expressed his inability, from any historical investigation, to come to a satisfactory conclusion as to who they were.

Prof. Rawlinson's paper *On the Ethnography of the Cimbri* was in favour of the Celtic theory of their ethnological character. He said that in favour of the theory that they were Germans the following considerations were urged:—The supposed etymology of their names; their geographic position before they began their wanderings in Jutland and between the Rhine and the Elbe; their close alliance with the Teutons, whom all allowed to be Germans; their physical characteristics, blue eyes and flaxen hair; some points of their manners and customs, especially the fact that their armies were accompanied to battle and directed by priestesses rather than priests; and, lastly, the statements of Julius Cæsar, Strabo, Pliny the elder, and Tacitus, who include the Cimbri in their lists of German nations. The advocates of the Celtic theory relied chiefly on five arguments: (1) the name Cimbri, which they identified with the term Cymry or Cymraeg, which was still the native name of the Welsh; (2) the almost unanimous authority of the Greek and Roman writers, excepting Julius Cæsar; (3) the individual names of Cimbri, which were Celtic; (4) the fact that the Romans employed Celts as spies to bring them intelligence of the designs of the enemy during the Cimbric war; (5) the manners and customs of the people, which were held to be far more Celtic than German. They also joined issue on the argument from the physical characteristics of the race, which they held to be, according to the description given, at least as near the Celtic as the German type. Prof. Rawlinson then proceeded to examine the various arguments, holding that the balance was in favour of the Celtic origin, though it was a point open to dispute, and unless fresh data should be obtained, which seemed very unlikely, would always remain among the vexed questions which would divide ethnologists.—Dr. E. A. Freeman dissented from Prof. Rawlinson's conclusions, holding strongly to the opposite theory. He especially censured his rejection of the evidence of Julius Cæsar and Tacitus.

The ethnology of New Zealand and Polynesia received much attention owing to the presence of two distinguished authorities, the Rev. Wyatt Gill, from the Hervey Islands, and Dr. Hector, of the New Zealand Geological Survey. The connection between the origin of the Maories and the Polynesians was brought out in a series of papers followed by a valuable discussion. Mr. W. S. Vaux, in a paper *On the probable origin of the Maori race*, concluded that the Maories were the descendants of the great colonising race of yellow men who originally migrated from Central Asia. The Rev. W. Gill then read a paper *On the origin of the South Sea Islanders.* Mr. Gill said that Mr. A. R. Wallace, in his "Malay Archipelago," has advanced the theory that the Polynesians are descended from a race which once overspread a vast submerged southern continent. As the land gradually sank, a few of the aborigines may have escaped to the tops of the loftiest mountains, around which subsequently coral reefs were found. Admitting that Polynesia is pre-eminently an area of subsidence, and its great widespread groups of coral reefs may mark out the positions of former continents, Mr. Gill believed that Mr. Wallace's reference was unwarranted. (1) Supposing that human beings inhabited this great southern continent at the period of the subsidence, and that a remnant escaped, it is not probable human life could have been sustained on the tops of these mountains for any considerable time, owing to the want of food and water. (2) The theory is utterly opposed to the native accounts of their own origin, which all point to the north-west. (3) The spread of the race can easily be accounted for on the basis of historical facts. In 1862 he saw on Manuâ, the easternmost island of the Samoan group, a small boat which had accidentally drifted from Moorea, a distance of 1,250 miles, and no life was lost. A few months later on in the same year Elikana and his friends drifted in a canoe from Manihiki to Nukurairae, in the Ellice group, lying N.W. of

Samoa, a distance of 1,360 miles. Half of the party on board perished from want of food and water. In both these instances the drifting was from east to west, before the trade winds. A far more remarkable event occurred in Jan. 1858, during the prevalence of the violent easterly winds, when a numerous family of adult natives drifted from Fakaofo, in the Union group, north of Samoa, to an uninhabited spot known as Nassau Island; thence to Palmerston's Island; and finally to Maugaia, where Mr. Gill lived; altogether a distance of more than 1,200 miles in a south-easterly direction. (4) The colour, hair, general physiognomy, habits, character, and especially the language, of the Polynesians clearly indicate a Malay origin. This could not be accidental. Mr. Gill's impression was that long ages ago the progenitors of the present race entered the Pacific from the S.E. fork of New Guinea, but were driven eastward by the fierce Negrito race. The greatest distance from land to land, as they pressed eastward, would be from Samoa to the Hervey group, about 700 miles, which had been successfully performed by natives in their fragile barks under Mr. Gill's own observation.

In the subsequent discussion Prof. Rolleston expressed his opinion that there was little difference between Papuans and Australoids; the superficial differences were outweighed by great radical points of resemblance. He referred to the Rev. S. J. Whitmee's paper in the *Contemporary Review* for February 1873 as of the highest value on this question of the origin of the races of the Polynesian islands. This opinion was diametrically opposed to Mr. Wallace's.—Dr. Hector described the three chief race-types among the Maories. The first was rarely met with except in the extreme south; it was of the same type as the aborigines of the Chatham Islands, with a distinct dialect, only comprehensible by old Maories. They had a sloping forehead and strong muscular ridges on their skulls, which were very distinct from the great majority of Maori skulls. The other two types were now pretty well intermixed. One was more common in the northern extremity of the Northern Island, having yellow shock hair and high cheek-bones. The third was the ordinary Maori. He mentioned the fact that the Maories had a much better knowledge of the natural history of their country than any people he had ever heard of. The older Maories had noticed and had distinct names for nearly all their plants, not merely those that were of use; and the same names, with slight modifications, were universally in use throughout a country a thousand miles in length. They had generic names by which they grouped plants according to their affinities in a way impossible to most people who were not educated botanists. The Veronicas of New Zealand appeared under a very great variety of external forms, yet they were all identified by one name.—The Rev. W. Gill, in closing the discussion, said that difference in shade of colour was not to be relied upon as a test of difference of race; for he had seen the most intense blackness produced in Polynesia in those of the poorer classes who habitually spent much time in salt water, while the wealthier classes remained of a much lighter hue.

General H. B. Carrington, of the United States army, read a very interesting paper *On the Indians of the North-Western States.*

The Anthropological Department has been one of the best sustained this year, a result attained by its inclusiveness of a wide range of subjects relating to the history of mankind, and by reason of the high authority of many who addressed the department on their respective studies. The President showed himself a worthy leader, illuminating most of the subjects discussed and fostering discussions which were interesting alike to students and to the general public.

SCIENTIFIC SERIALS

American Journal of Science and Art, September.—The original articles are: On the formation of hail in the spray of the Yosemite Fall, by W. H. Brewer. The paper describes a visit paid to the fall in April last. The amount of water passing over the fall was estimated at 250 or 350 cubic feet a second, and the height is 1550 feet. In the spray, which stung the hands and faces of the visitors, hail or ice-pellets were found. "It will be noticed that at the time when this hail was observed, the sheet was in the full blaze of the sun from top to bottom. . . . The air near was of a temperature of 70°. Prof. Le Conte has suggested that perhaps the cooled air within the sheet is somewhat compressed and condensed in the base of the fall, and when liberated just outside by its expansion, freezes a part of the spray." —On Southern New England during the melting of the great glacier, by J. D. Dana: Part I. (we reserve our notice till the completion of the article).—On the mechanical work done by a muscle before exhaustion, and on the "law of fatigue," by the Rev. S. Haughton, M.D. Dr. Haughton announces his aim is be to show (1) That both series of experiments made by Prof. Nipher (given in the February number) are a valuable contribution to the facts of animal mechanics; (2) That they are not only consistent with "the law of fatigue" proposed by Dr. Haughton, but illustrate both that law and his "Coefficient of Refreshment;" (3) That Prof. Nipher's discussion of his own valuable experiments is worthless, as it is based on an empirical formula, which has no meaning and leads to no further consequences: (4) That the law of fatigue, which explains not only Prof. Nipher's experiments, but so many other experiments also, is entitled to be received provisionally as a law of animal mechanics, and followed up by deduction to its legitimate conclusions.—Earthquake of December 1874, by Prof. D. S. Martin. "The general phenomena presented nothing peculiar."—On some interesting equine calculi, by R. H. Chittenden.—Results of dredging experiments off New England coast, by A. E. Verrill. Four pages of tables are given, and a note is added on methods of preserving specimens. Picric acid was found to be valuable. —On the passage of two bolides in 1872 and 1874 over Middle Kentucky, by J. Lawrence Smith.—Notes on the gases accompanying meteorites, by Prof. J. W. Mallett. The purpose is to question whether Prof. Wright has sufficient evidence for his conclusion, "the stony meteorites are distinguished from the iron ones by having the oxides of carbon, chiefly the dioxide, as their characteristic gases instead of hydrogen."—On a new vertical lantern galvanometer, by Prof. G. F. Barker. The arrangement is for demonstration to a large audience, deflections obtained by induction currents, thermo-currents, voltaic currents, &c.—On another gigantic Cephalopod (*Architeuthis*) on the coast of Newfoundland, December 1874, by A. E. Verrill. The total length is estimated at forty feet.

THE *Journal of the Chemical Society* (June 1875) contains in detail Prof. Clerk-Maxwell's paper On the dynamical evidence of the molecular constitution of matter, which was duly published in NATURE. The other papers in this part are:—Researches on the action of the copper-zinc couple on organic bodies, by Dr. J. H. Gladstone and A. Tribe. The authors in this (eighth) paper treat of chloroform, bromoform, and iodoform.—On the action of nitrosyl chloride on organic bodies (second paper), by W. A. Tilden; the action on turpentine oil is considered.—A note by Prof. Story Maskelyne on the crystallographic characters of nitrosoterpene is given as appendix to the last paper.—Dr. H. Armstrong contributes a note on isomeric change in the phenol series, which gives new proof of the energy and unceasing attention this gentleman bestows upon his interesting researches.—The last paper is a note on the effect of passing the mixed vapours of carbon disulphide and alcohol over red-hot copper, by Th. Carnelley. It was found that the following bodies were formed: $CH_3.COH$, COS (carbon oxysulphide!) C_2H_4, C_2H_2, CH_4, and H, and neither H_2S nor SO_2. The copper is superficially converted into sulphide, and amorphous carbon is deposited.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Aug. 1.—This number contains the concluding part of Herr Wilczek's paper on the calculation of the arithmetical mean of constant quantities. Also an account, by Herr von Jedina, of a cyclone encountered by the corvette *Helgoland* in the North Atlantic, remarkable for the steadiness with which the wind blew from east at its commencement, the great expansion of the front in comparison with the rear, and the slow rise of the barometer after passing the centre.—Among the Kleinere Mittheilungen is a notice of the late Dr. Theorell, and a paper by Herr C. Braun, on the theory of storms.

Rendiconto delle Sessioni dell' accademia delle scienze dell' istituto di Bologna.—The longer papers read at the Academy during the academical year 1874–5 were twenty-nine in number, besides numerous notes and memoirs of smaller interest. We note the following, as of special interest to our readers:—On some phenomena consequent upon contusions of the abdomen and of the spine, by Dr. P. Loreta.—On some argillaceous slate of Miocene origin, by G. A. Bianconi.—Several papers by Prof. F. Selmi, on researches made on poisonous alkaloids, their differences in properties, their determination when mixed with others in organic matter and with innocuous alkaloids,

&c.—Helminthological observations by Dr. Ercolani, on dimorphisms, on *Filaria immitis*, and on a new species of dog Distoma.—Anatomical description of the eye of the European mole, by Dr. Ciaccio.—On the organisation of the brain of Eolidida, by Dr. Trinchese.—On the changes of form of *Amœba limax*, by the same.—On a non-microscopic new and rare parasitic fungus, which is developed on the larva of a living cricket, by G. Bertoloni.—Analytical remarks on some theorems of Feuerbach and Steiner, by Prof. E. Beltrami.—On the continuity of feeling, by Dr. D. C. Biagi.—On the reasons of the low statures which were generally observed amongst the conscripts of the last decennium in some communities in the neighbourhood of Bologna and other districts of Italy, by Dr. P. C. Predieri.—New observations on the minute structure of muscular fibre, by Dr. Ercolani.—Proofs for the contemporariness of the glacial epoch with the Pliocene period at Balerna and at Monte Mario, on the Rhine, by G. A. Bianconi.—On the effects of electric sparks on phosphorus in hydrogen, in nitrogen, in ammonia, and in muriatic acid; and on the effects of electric currents on water, on sulphuric acid, on alcohol, and on bisulphide of carbon, by Dr. Santagata.—Researches on capillary tubes, by Prof. Villari.

Sitzungsberichte der naturwissenschaftlichen Gesellschaft Isis in Dresden, October to December, 1874.—The meetings of this society are divided into five classes, besides general meetings, viz., one for mineralogy and geology, one for prehistoric archæology, one for chemistry, physics, and mathematics, and one each for botany and zoology.—The more important papers read in the different sections during the last three months of 1874 were:—In the mineralogy and geology class: On a peat-like formation occurring at Lindenau, near Leipzig, containing a great number of beetles, one or two species of which are now extinct, by Von Kiesenwetter. On a number of minerals collected during a tour in Saxony, by E. Zschau. On the occurrence of calc-sinter near Quedlinburg, by Herr Ackermann.—In the botany class: On hedge plantation in Australia, by W. Ferguson. On the culture of plants in rooms, particularly of Palmæ, by Adolph Petzold. Report of the results of botanical excursions made during 1874, by A. Voigt.—In the zoology class: Remarks by Th. Kirsch, on "Darwinism and the Researches of Cuvier and Newton," a work lately published by Herr Wiegand.—On Haeckel's calcareous sponges and his Gastræa theory, by Herr Ebert.—In the archæology class: Report on the Archæological Congress at Stockholm, by Dr. Mehwald. On some flint implements from the cave near Rochefort, by Dr. Geinitz. On a piece of reindeer horn upon which rough drawings of horses are visible, and which was found near Thayingen, in Switzerland, by the same.—In the physico-chemical class:—On ozone, by Dr. Schürmann, a highly interesting and elaborate paper; the author gives a detailed account of the history of ozone, and then speaks of its properties, preparation, reactions, presence in the atmosphere, action on the animal organism, and thoroughly exhausts the subject. On tables for barometrical measurements of heights, by Prof. Neubert. Meteorological phenomena observed at Dresden during 1874, by Herr Fischer.—At the general meetings, a paper on the earthquakes of the sixteenth and seventeenth centuries was read; the others being all of minor interest.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Sept. 13.—M. Frémy in the chair.—The following papers were read:—A note by M. Faye relating to the approaching eclipse of the sun.—M. Bertrand then made some remarks on the paper read at the last meeting by M. Bienaymé.—Report on a memoir by M. Lefort, entitled "Critical examination of the basis of calculation usually adopted to appreciate the stability of metal bridges with straight prismatic beams, and propositions for the adoption of a new basis."—Report on M. Boussinesq's paper on the theory of flowing waters.—Memoir on the observations made at Peking of the Transit of Venus, by Mr. J. C. Watson, chief of the American expedition.—A note on the greasy matter in the grain of the oil-tree of China, by M. S. Cloez.—On the development of Heteropoda, by M. H. Fol.—On the migrations and metamorphoses of marine endoparasitic Trematoda, by M. A. Villot.—On some reactions of hæmoglobine and its derivatives, by M. C. Husson.—On the probable origin of the two hailstorms observed on July 7 and 8, in some parts of Switzerland and the South of France, by M. D. Colladon.—On the non-regeneration of the crystalline lens in man and in rabbits, by M. J. Gayat.

VIENNA

K.K. Geologische Reichsanstalt, April 6.—On Miocene chestnut trees, by O. Heer.—Diallogite after manganese blende and barytes; pseudomorphs after fahl-ores of Przibram, by Ed. Döll.—On the occurrence of native gold in the mineral shells of Verespatak, by F. Posepny.—On the Culm flora of the Moravian-Silesian roofing slates, by D. Stur.

April 20.—On remains of *Ursus spelæus* from the cave of Igritz, by F. von Hochstetter.—On the meteorite of Lancé, by R. von Drasche.—On a geological detailed map of the surroundings of the Seisser Alp and of St. Cassian, by E. von Mojsisovics.—On a map of the upper Vilnöss and the lower Enneberg valleys, by R. Hörnes.—Geological report from the investigation district of the Oetz-valley group, by G. A. Koch.

May 4.—Presentation of a new special map of the Austro-Hungarian Monarchy, F. v. Hauer.—Characteristics of some minerals occurring on the Przibram ore deposits, by F. Babánek.—Report by Dr. E. Tietze from his travels in Persia.—On a new fossil resin from the Bukowina, by J. von Schröckinger.—On *Cervus megaceros* from Nussdorf, by Dr. F. von Hochstetter.—On a human cranium found in the diluvial Loess of Manners-Porf, by Dr. J. Woldrich.—On Noric formations in Transylvania, by E. von Mojsisovics.—On the phosphorites of the Lavant valley, by H. Wolf.

GÖTTINGEN

Royal Society of Sciences, July 10.—At this meeting of the Society the following papers were read:—On the electric elementary laws, by Herr Riecke.—A note on the toxicological action of phenols, in particular of thymol, by Th. Husemann.—On Rötteken's eye of Actinia, by Dr. Hub. Ludwig.—A note by Herr Fromme on the maximum of temporary magnetism in soft iron.—On the potential function in space extended in several directions, by M. Jouelli.

BOOKS AND PAMPHLETS RECEIVED

British.—The Royal Tiger of Bengal: Dr. J. Fayrer, M.D., F.Z.S. (Churchill).—Jummoo and Kashmir Territories. A Geographical Account, by Frederic Drew, F.R.G.S., F.G.S. (E. Stanford).—Proceedings of the Berwickshire Naturalists' Club.—Brande and Cox's Dictionary of Science, Literature, and Art. 3 vols, new edit. (Longmans).—Further Researches in the Mathematical Science, by the author of "The Two Discoveries" (Bridgewater, Pine).—Bristol and its Environs (Bristol: Wright and Co.)—The Geology of British Guiana: C. S. Brown, F.G.S., and J. G. Sawkins, F.G.S, (Longmans).—A Manual of Mollusca: S. P. Woodward, A.L.S, F.G.S. (Lockwood).—The Native Races. Vol. iii.: Hubert Howe Bancroft (Longmans).—Tapeworms: T. Spencer Cobbold, M.D., F.R.S, F.L.S. (Longmans).—An Introduction to Animal Physiology: E. Tully Newton, F.G.S. (Murby).—The Abode of Snow: Andrew Wilson (Blackwood).—Quarterly Journal of the Geographical Society (Longmans).—Journal of the Scottish Meteorological Society (Blackwood).

Colonial.—Centrifugal Force and Gravitation. Six parts: John Harris (Montreal).—The Immortality of the Universe: J. A. Wilson (Melbourne, G. Robertson).—Report of the Meteorological Reporter of Bengal.—Report of the Nidnapore and Burdwan Cyclone.—Magnetical and Meteorological Observations at the Magnetic Observatory, Toronto, Canada, 1841 to 1871 (Toronto: Copp, Clark, and Co.)

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THURSDAY, SEPTEMBER 30, 1875

*THE SCIENCE COMMISSION REPORT ON THE ADVANCEMENT OF SCIENCE**

IN our last article under the above head we commenced our analysis of that part of the Commissioners' Report which deals with the Administration of Science. In our present article we shall conclude our notice of the Report by stating the chief arguments and opinions of the witnesses regarding the formation of a Council of Science. Thus, following the evidence of Sir Wm. Thomson and Dr. Frankland, to which we have before referred, we find Dr. Hooker, Admiral Richards, General Strachey, Dr. Roscoe, Dr. Balfour Stewart, Dr. Sclater, Mr. De la Rue, Sir H. Rawlinson, and others in favour of a Council, while the Astronomer Royal, Prof. Owen, Lord Salisbury, and Lord Derby are opposed to its formation.

Admiral Richards, late Hydrographer to the Navy, is of opinion that the appointment of a Minister of Science and of a Council stand and fall together; and thinks "that the one would not be of very much value without the other."

Dr. Sclater's idea of the Council is as follows:—

"The heads of the different scientific institutions that are put under the control of the department of science and the minister of education might form a consultative body and be called a council of science, and that there might be certain other members added to assist them in deliberation, if it were thought necessary, such as representatives of the College of Physicians, the College of Surgeons, and of the scientific branches of the army and navy.

"Most men of science, I think, see that something of the sort is imperatively required. All lament the piecemeal way in which scientific subjects are dealt with by Government, in consequence of their being subdivided amongst all these different offices, and of there being nobody to appeal to upon a question of science, and therefore I think the proposal to establish such a Council would meet with universal acceptation amongst scientific men."

Dr. Hooker, the President of the Royal Society, gives it as his opinion "that the general proposition, that the Government should be aided by scientific persons, is an excellent one, both with respect to the administration of the existing Government scientific institutions and with respect to the occasional grants which the Government may be called upon to make for scientific objects." Like Dr. Roscoe, he thinks that the Council should not consist exclusively of scientific men.

Mr. De la Rue considers that the usual permanent staff of a secretary and assistant secretaries, as suggested by Prof. Owen, even if they were men of science, would not be sufficient; urging as a reason that science is really now so extensive that one could hardly imagine any secretary to be so intimately acquainted with every branch of science as to be able, even with the aid of his assistant secretaries, to advise, or to point out where to obtain specific information on every question which might be brought under consideration. Nor does he think the Government Grant Committee, a body regarded with favour by many witnesses, could be so modified as to render a special Council unnecessary.

Sir Henry Rawlinson regards the nomination of a Permanent Council of Science as the natural remedy for the "spasmodic" action on the part of the Government; and another Indian officer, General Strachey, gives the following important evidence:—

"The persons who are employed in the public administration are certainly as a class not amongst those who have anything deserving the name of scientific education; therefore, for a long time to come, it is not to be expected that the members of the Government, or their chief subordinates, will have any such general knowledge of science as would enable them at all satisfactorily to deal with the scientific questions which come before them. Therefore I conclude that it is absolutely essential for the Government, under any circumstances, to get advice from outside; and then comes the question as to how this advice is to be got. If there is no recognised and regularly organised body whose business it is to give advice to the Government on such subjects, then the only thing that a minister can do is to get his information from unrecognised and irresponsible authorities, persons whose opinions, perhaps, may be very valuable, but still persons of whom the public never can have any cognisance; and private advice given in that way seems to me given in the worst possible form. If, then, that form of advice is bad, how can you obtain advice of proper intrinsic value on the multifarious subjects on which it is certain to be needed by an administration really striving to advance science to the utmost, and how can you secure its being given under a sufficient sense of responsibility, and in such a way as to carry the greatest weight possible to the mind of the minister who is expected to act upon it? And here I would repeat that any specific proposal to give effect to such an idea must be made to fit into the general form of the administration; and I therefore consider that the best course would be to adopt the proposal that has been made by many persons, that there shall be some sort of council constituted to advise the responsible Government department as to its proceedings in connection with science."

He then proceeds:—

"I would take the opportunity of saying that it is a question that is open, and which I believe has been discussed, whether the Council, for instance, of the Royal Society, with or without any addition, might not be made to perform satisfactorily some or all of the functions which it has been suggested should devolve upon this Commission. But I think not. And the principal reason that I have for thinking that such a body as the Council of the Royal Society is not suitable for the purpose is, that it cannot have that specific responsibility put upon it which should be put upon a body such as I have spoken of, and that it is got together for totally different purposes and objects. The Council of the Royal Society has to manage the business of the Royal Society, and is not at all selected to advise the Government on matters connected with the advancement of science, or the application of science in the operations of the public departments."

He further points out that the Minister would have a perfect right to repudiate any scheme which the Royal Society might put forward, or any advice they gave—that he would be justified in doing so on the ground that he was not responsible for their selection.

Capt. Galton points out that "the institutions which are maintained by the State for scientific purposes are maintained upon no principle whatever with regard to their administration. You have got the British Museum under trustees, you have got South Kensington under the President of the Council, you have Kew under the Office of Works, you have the Botanic Gardens at Edinburgh, I think, under the Queen's Remembrancer. You have the Observatory at Edinburgh as part of the University of Edinburgh, and you have the Observatory at Greenwich under the Admiralty, besides several others. You have every possible variety of jurisdiction, and, consequently, it seems to me that you have a great waste of power; there is the School of Chemistry, and the School of Mines, and the Museum at Edinburgh, all under South Kensington Museum, and the Meteorological Department, which is partly under the Royal Society and partly under the Board of Trade. There is no possibility of getting any correlation between those different scientific bodies, and if you are to get proper unity of administration you must bring them all under one head, or to one focus. I should recommend placing them all under a scientific commission or council, and I should place that council probably under the Privy Council; but I should make it a body for administering all questions connected with all the scientific institutions, or all grants made by the Government for scientific purposes in the country, and I should give to this council the same status, with regard to its administration, or very much the same, that the Indian Council have. . . . . The parliamentary head of the department, if he differed from them in opinion as to their recommendations upon the scientific questions connected with those institutions, or any other that might be founded, should record his differences of opinion in a minute."

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* Concluded from p. 432.

Dr. Siemens would "assemble the heads of departments at frequent intervals for the discussion of general questions, and would propose to add to their number such men as the president of the Royal Society, the president of the Institution of Civil Engineers, and at least one representative of the two great Universities. This Board would decide general questions appertaining to the advancement of science."

We could fill many more columns with evidence analogous to the above samples. Making due allowance for the different ways in which a new and complex question like this, compounded of scientific, political, and administrative elements, must present itself to a variety of minds trained to dissimilar pursuits and habits of thought, the almost general consensus as to the necessity of some such advising body as that proposed is most striking.

Still those who object to the creation of a Council on various grounds are not wanting, and we now glance briefly at the evidence of these witnesses.

Sir G. Airy thinks a paid Consultative Council could not do very much to assist the Government, and that the Council of the Royal Society would be the best body to which the Government could have recourse in any matters of that kind.

Prof. Owen prefers a Minister of Science, with a permanent Under-secretary and administrative staff, as in his opinion the representative of any particular branch of science on the Board would have too great an influence.

The Earl of Derby is very sceptical either as to the necessity, or as to the utility, or as to the successful working of such a Council. One objection he urges is that if matters for which the head of a department is responsible are to be referred to the Council, and if upon those matters the Council is to pronounce an authoritative opinion, the responsibility of Ministers to Parliament will be considerably lessened.

In reply to the suggestion that one function of the Council would probably be to advise the State as to the application of money for the higher teaching of science and for scientific research, and also to advise the Government with respect to any applications that may come before it for grants of money connected with science, whilst objecting to a Council, Lord Derby thinks that it is a matter which falls strictly within the province of the Minister of Education.

Lord Salisbury is opposed to a Council because he has never seen anything to lead him to believe that such a Council of Science would have anything to do; and he considers that the Government would always get better opinions on any scientific point that arises, by applying to the most distinguished scientific man in that particular branch at the time, than it would by having a set of permanent officers to give advice on such subjects.

There appears to have been before the Commission practically three solutions of the question. First, that no change should be made in the present condition of things. The Astronomer Royal is apparently the sole witness of eminence in science who seems to desire no reform in the scientific administration of the country. Secondly, that the Council of the Royal Society should be constituted the official advisers of the State—a view held generally by those who are adverse to the creation of a new Council; and third, that a Council be provided to assist the Minister charged with science and the Departments concerned with science.

The Commission arrive at the conclusion that the balance of argument and authority is in favour of the last-named arrangement, which accordingly they recommend in terms which, though general, leave no doubt that they contemplate the creation of a new official body so constituted as fairly to represent the various branches of science. We think that no unprejudiced and competent person can read the whole evidence without accepting this conclusion as undeniably sound, if not indeed absolutely unavoidable.

THE GOVERNMENT RESEARCHES IN PATHOLOGY AND MEDICINE

THE third volume of the "New Series of Reports of the Medical Officer of the Privy Council and Local Government Board," brings before us another instalment of the work paid for by the annual grant of 2,000*l.* "in aid of scientific investigations related to pathology and medicine." This grant has been actively opposed by a small minority in the House of Commons mainly upon the narrow and invidious ground that the medical profession was thereby obtaining knowledge and instruction which the medical profession ought to obtain at its own expense. "The medical profession lives upon the public; the medical profession makes use of its knowledge to extract money from the public; the grant will add to the knowledge which the medical profession uses with such object—therefore the grant is money drawn from the pockets of the public to aid in the further depletion of the pockets of the public."

Such appears to be the main inspiration of the opposition. Whoever will be careful to read the last public report, and the short but most weighty statement with which Mr. Simon introduces it to his chiefs, will see plainly that this kind of opposition is founded in misapprehension or ignorance. The information sought is such as may help to inform the State how to offer most effectual resistance to the introduction of disease from without, and to the extension of disease within. It concerns resistance to typhoid fever, small pox, and many other diseases of well recognised contagious nature, and the possibility of controlling the extension of diseases less recognised as having like nature, as for instance what Mr. Simon calls "the tubercular infection." "It aims to be a systematic study of the intimate pathology of the morbid infections, acute and chronic."

Mr. Simon in his remarks points out that much of the study involved is most elaborate and purely scientific, never immediately convertible to pecuniary profit, but perhaps, on the contrary, involving heavy cost; not pretending to immediate popular application, but addressing itself primarily to the deeper scientific requirements of the medical profession, and therefore in an extreme degree technical. Studies of this sort cannot be cultivated to any adequate extent by private medical investigators, and the scientific investigations set going by the 2,000*l.* grant have a distinctive intention to supplement the ordinary resources of private medical observation in the direction already indicated. The work connects itself with the objects of preventive rather than with the objects of curative medicine, and in addition to investigations into the ætiology of infective diseases, it includes some very elaborate research concerning normal standards, histological and chemical, of the tissues involved in the morbid infective processes.

The latest published volume, entitled "Report made to the Lords of the Council on Scientific Investigations, made under their direction, in aid of Pathology and Medicine," contains the result of five researches:—(1 Dr. Sanderson's Further Report on the Intimate Pathology of Contagion; (2) Dr. Klein's Research into the Contagium of Variola Ovina; (3) Dr. Klein's Research into the Lymphatic System and its relation to Tubercle; (4) Dr. Creighton's Anatomical Research towards the Ætiology of Cancer; (5) Dr. Thudichum's Research into the Chemical Constitution of the Brain.

Dr. Sanderson's paper is a sequel to a former Report on the nature of infecting agents or contagia, in which Chauveau's opinion, expressed in the sentence "All contagia are probably particulate," was supported. The present paper treats of the infecting agents and morbid processes in diphtheria, erysipelas, splenic fever, and relapsing fever. In relation to all of these a mass of evidence collected from many observers is adduced to show that vegetable forms are connected with the contagions or with the morbid process. In splenic fever and relapsing fever organisms of a distinctive and specific form are declared to be present in the blood; bacterium-like rods accompanying splenic fever, minute organisms to which the name of *spirilla* has been given accompanying relapsing fever. In an "addendum" some observations of Dr. Letzerich, of Bramfels, Nassau, and of Dr. Oertel, of Munich, on the inoculation of animals with diphtheric poison are reported. From these it appears that in animals receiving the poison (derived from the throat of a child) by subcutaneous injection, the characteristic affection of the throat was developed after a few hours, and that the infiltration of tissues with the same sort of micrococci as are found infiltrating them in diphtheria always occurred.

Dr. Klein's first communication relates to the contagium of Variola Ovina, and describes certain small organised forms—bacteria, micrococci, and microsphæra gathered into colonies by long filaments—as found in the lymph from vesicles. The same forms are found in cavities formed in the rête Malpighii and subjacent corium, where the pock is developed after inoculation, extending afterwards into and occupying in vast numbers the lymphatics of the corium.

Dr. Klein's second communication treats of the Lymphatic System in relation to Tubercle. It commences with a minute and original description of the microscopical anatomy of the serous membranes, and their relation to the lymphatics, and compares with this the conditions in acute and chronic inflammation, noting in particular the processes leading to the formation of new blood-vessels and lymphatics both in healthy and diseased membranes. The second part of this communication relates to the lymphatics of the lungs in health, in certain chronic inflammations, and in tubercular infection. The appearances in the lungs of guinea-pigs after the production of artificial tuberculosis and in human lungs in tuberculosis are compared. Dr. Klein comes to the conclusion that the two processes are only to a limited extent similar (a conclusion opposed to the opinions of Sanderson and Wilson Fox). According to Dr. Klein, "in artificial tuberculosis of the lung of the guinea-pig the parts first attacked are the small branches of the pulmonary artery or pulmonary vein, whereas in acute miliary tuberculosis of man the capillary blood-vessels of the alveoli seem to be the tissue from which the action of the morbid agent starts.

Dr. Creighton's paper is a very thoughtful contribution to the present knowledge of cancer. It relates some unsuccessful attempts to propagate cancer by inoculation, and a number of careful observations as to the process of formation of secondary cancerous tumours. The attention is chiefly fixed upon the epithelium in relation to hyperplastic and heteroplastic (endoplastic) growth. Dr. Creighton infers from his observations that the efficient cause of secondary tumours in the liver is the substitution of the endoplastic for the normal (or excessive but still homo- though hyper-) plastic activity of the liver cells. The operation of deeper or extraneous causes is discussed, but left undecided. Hope is expressed that aids to a decision may be obtained from the results of a systematic examination of mammary tumour now proceeding.

Dr. Thudichum's research is a study of the normal chemical constitution of the brain, undertaken to prepare the way for a study of the brain in fevers, and other morbid states and processes. The paper is very long, occupying more than half of the 247 pages of the Report, and most elaborate. Dr. Thudichum believes that he has both added to and corrected former knowledge of the chemistry of the brain. In particular he describes with careful detail a number of newly observed principles, both phosphorised and nitrogenised. Among the phosphorised, kephalin and myelin (both of which contain nitrogen, as well as phosphorus) are new, and are associated with lecithin. They are described as typical colloids, of no true solubility, of almost indefinite power of soaking up water so as to form an imperfect solution, of feeble chemical activity, of a remarkable readiness to combine with acids salts and alkalies, and to part with them on the addition of excess of water. Kephalin and myelin are stable, lecithin so unstable as to elude proper analysis. Similarly the nitrogenised bodies, cerebrine (Müller's), kerasine, and phrenosine, are colloids, but of less perfectly marked type, and less interesting natural history.

In his summary Dr. Thudichum, speaking of the phosphorised bodies, remarks that "we have therefore here a diversity of affinities such as is not possessed by any other class of chemical compounds in nature at present known; and the exercise of these affinities being greatly influenced by the mass of reagent and the mass of water which may be present, the interchange of affinities may produce a perfectly incalculable number of states of the phosphorised and consequently of brain matter. This power of answering to any qualitative and quantitative influence by reciprocal quality or quantity we may term the state of *labile equilibrium;* it foreshadows on the chemical side the remarkable properties which nerve matter exhibits in regard of its vital functions."

The volume now under consideration has been preceded by two volumes, containing a first and second report by Dr. Klein, on the Lymphatic System and its relation to Tubercle, a report by Dr. Sanderson on the Infective Products of Inflammation, and by Dr. Thudichum on Chemical Changes in cases of Typhus. Reports are now in course of preparation by Dr. Baxter on Disinfectants, by Dr. Sanderson on the Febrile Process and on Infective Inflammations, by Dr. Thudichum on the Chemical Constitution of the Brain, by Dr. Creighton on Anatomical Studies with reference to Cancer, by Dr. Klein on the Contagium of Enteric Fever. The whole represents four years' work, for which 8,000*l.* has been voted. The value and importance of all this work in relation to the welfare of the community, as a contribution in aid of preventive medicine, cannot be doubted by any careful reader of the record. Nor, after even a superficial reading of the record can there be doubt but that the work is of a kind which can only be set going by such means as public grants, since it involves a special training and a special devotion inconsistent with the earning of livelihood by other direct or incidental means. The grant is on the evidence justified.

But there are other aspects of the work which claim a serious regard. The department of the Government concerned in protecting the country from the invasions of contagious disease, whether represented by Minister of Health or principal medical officer, needs in all things to be fully informed of the latest discoveries in pathology, hygiene, and therapeutics. Of such minister or officer the body of scientific men whose work is here recorded, together with others who are engaged in sanitary investigations and inspections under the central authority—men like Drs. Seaton and Buchanan and Mr. J. N. Radcliffe—constitute a body of advisers or council representing the most advanced knowledge bearing upon the public health. They constitute a council to which the minister or officer may refer for latest knowledge when legislation is concerned, or for practical advice when action has to be taken. They are, in fact, at this moment practically such a council. In the Science Commission Report on the Advancement of Science, the formation of a similar council as adviser of a Minister of Science is advocated. We would suggest that we have in what we have stated an excellent illustration of the principle proposed, with a wider application, in the Science Commission Report.

THE INFLUENCE OF THE PRESSURE OF THE ATMOSPHERE ON HUMAN LIFE

Influence de la pression de l'air sur la vie de l'homme. Par D. Jourdanet. 2 vols. (Paris: Masson, 1874.)

AFTER having practised medicine for six years on the borders of the Gulf of Mexico, and rendered himself familiar with the diseases and conditions of life of the inhabitants of low levels, M. Jourdanet removed to the elevated plateau of Anahuac—more than 2,000 metres above the sea level. Here, as might have been anticipated, he found the pathological conditions different, but to his surprise he discovered that the differences were not simply such as result from temperature, or are paralleled in places of lower level and higher latitude, but presented peculiarities which he conceived to be dependent on the elevation of the situation alone. A residence of twenty years in the locality enabled him to confirm this idea and to prove that, while the blood of the inhabitants presented no poverty of corpuscles, the corpuscles themselves were deficient in oxygen, on account, as he believed, of the too feeble pressure of the atmosphere in these high regions. This led him to undertake the study of the whole question of the influence of the atmospheric pressure on health, and to call to his aid M. Paul Bert, Professor of Physiology at the Sorbonne, by means of whose experiments he believes himself to have arrived at some definite results. These, with every other possible point of interest connected with the subject, he now presents us with, in two large and beautifully illustrated volumes; leaving, however, the details of the physiological experiments to be published in a forthcoming work by M. Bert himself.

The question so fully discussed by M. Jourdanet is certainly of very great interest, and, in spite of previous observations and opinions on the therapeutic action of compressed air and on the possible limits of life in regard to height and other similar points, it is also of some novelty as treated by him.

According to M. Jourdanet the pressure of the atmosphere has not always been as small as it is now; and assuming, what is probably true, that a greater pressure would involve greater heat, he would account in this way for the warm periods known to have existed in Tertiary times. This leads him to make an hypothesis as regards the cause of the glacial epoch, the occurrence of which would be contrary to the above theory; but it is not an hypothesis that could recommend itself to geologists. The glacial epoch arose, he imagines, in this way: by some sudden convulsions the crust of the earth was torn open, and prodigious quantities of gas and vapour driven up, which forced up the atmosphere to a prodigious height, where it was chilled and its vapour condensed, which fell in diluvial torrents, leaving the air so free from vapour that radiation took place at an enormous rate, chilling the earth and causing the glacial epoch! He also concludes that on account of the too great density of air in the plain, man must have made his first appearance on elevated plateaux, and he accounts in this way for the veneration of high places among the early races. These and similar speculations, though they may sometimes amuse, do not detract from the real merit of the work in more determinable matters.

We reach the substantial part when we come to the experiments of M. Bert, of which the results are here given. Small animals were placed in chambers of various capacities, which were then filled by the same absolute quantity of air, necessarily at various pressures; when the animals were dead, the remaining air was analysed, and it was found that in the larger vessels the proportion of oxygen was greater, and this proportion was such that the total amount of oxygen left was proportional to the capacity of the chamber. The animals died as soon as the oxygen by itself was reduced to a density of 4 per cent. of what it would be if the whole chamber were filled with it at the normal pressure—the amount being thus independent of the quantities of the other gases present. This being true for any sized chamber, it follows we may suppose the chamber indefinitely large; and an animal would die in the open air if the oxygen should have less pressure by itself than 4 per cent. of 76 millimetres. Taking the air to have its ordinary 21 per cent. of oxygen, these experiments would appear to prove that life is impossible in air of less pressure than 14·5 mm. The proportion of oxygen, however, seems to be much less than that which is ordinarily supposed to be small enough to produce asphyxia. Further experiments were performed, pointing to the same result. Dogs were so fastened that they could breathe only from a bag of limited size, and from time to time the air in the bag and the blood of the dog were analysed, and it was found that the oxygen in both decreased *simultaneously*, though not at the same rate. These and similar experiments, together with the fact ascertained by M. Jourdanet, that the blood of Mexican dogs contains a less proportion than usual of oxygen, are the proofs offered that the blood cannot be sufficiently oxygenised for health without a certain amount of atmospheric pressure.

In all these experiments, however, no allowance is made for the possibility of the human lungs accommodating themselves in time to the smaller pressure, so as to enable the blood to take up a sufficiency of oxygen; and this objection is seen by M. Jourdanet, who, after giving an interesting account of the various evils that have befallen noted climbers, discusses the question whether an increased number of respirations, or an enlargement of the thorax, could counteract the effect of the rarity of the air. As to the first, numerous experiments on himself during his residence in Mexico have enabled him to verify the law given by Lehmann, that the carbonic acid expired is in part constant and in part only variable with the number and magnitude of the respirations; and he calculates from hence that, in order to counteract the loss of pressure and diminution of oxygen by increased respiration, it would require twenty-four ordinary respirations per minute, which of course the Mexicans do not make. As to the size of the thorax, which has been stated by Forbes to be larger in the inhabitants of these high regions, he objects that this statement was made on too restricted data, and that Coindet has found that it does not generally hold true. Whatever may be the truth on this point, the explanation which M. Jourdanet offers of the result of the low pressure on the temperature of the body cannot be considered satisfactory. He considers that, as a general rule, the temperature of Mexicans is not below the average, although their surface temperature often is, and that the loss of heat which would arise from the more easy radiation and the lower oxygenisation of their blood is prevented by "the repose of their functions," while their respiratory organs are specially modified so as to be capable of "exceptional exercise." The latter would require proof, and as to the former, although the body must lose temperature by the exact amount of work done on external objects, "a care to avoid every effort" would prevent the body doing work upon *itself*, and less heat would therefore be produced. The "apathy" of the Mexicans and other inhabitants of high levels must have another cause than this.

M. Jourdanet's work ranges over a wide field, discussing, without much plan, various points in connection with the climate of plateaux. Thus, in one chapter he attempts to prove, by statistics of population, that the low pestilential area round the Gulf of Mexico is more healthy than the elevated table-land, the former having increased six per thousand and the latter three per thousand in forty-seven years; that the decadence of the Peruvian race is due to the influence of the atmosphere, without apparently seeing the obvious objection that they must have *risen* under the same influence, since they are a very ancient race; that the mental and physical work of the Mexicans is below that of the inhabitants of the plains; and then he discusses the extreme height at which it is possible to live permanently, which he places between 4,000 and 5,000 metres. This variety makes the book very readable, but, in spite of its large size, the arguments on many points are too brief to be convincing.

The second volume is engaged in discussing the influence of atmospheric pressure on disease, M. Jourdanet being "convinced that the true nature of exterior influences is far better seen in the maladies caused by them than in the health which they favour." This portion of the work has a principally medical interest, although some of the results of his experience may be usefully mentioned. He finds that consumption is rare in Mexico, and is principally confined to the poorer classes who have insufficient nourishment, which he explains by their feebly oxygenised blood being unfavourable to the development of the disease;—typhus fever, on the contrary, finds there its most suitable subjects, as do other inflammatory disorders, while yellow and intermittent fevers are almost unknown.

The elevation of the country where these observations were made, and concerning which M. Jourdanet's conclusions have been arrived at, is 2,000 metres and over; and the climate of these places he speaks of as "climats d'altitude;" while intermediate heights he characterises as "climats de montagne;" to which latter he also devotes a few chapters. These, however, are of less interest as not embodying the results of his personal observations, but being a discussion of the various well-known moral, mental, and physical characteristics of mountaineers. To these follow chapters on the influence of mountain travelling on health, and detailed experiences of the application of artificial rarefaction of the air in disease.

With the desire of making the work as complete on the subject as possible, the author has compiled a large part of it from well-known writers, and recapitulates much that is of everyday observation; and these parts have naturally less interest than those which deal directly with his Mexican experiences. The whole of the facts, however, which bear upon the question discussed are conveniently collected together and put in an interesting form for the perusal of the general reader, for whom, however, much of it has too medical an aspect.

OUR BOOK SHELF

The Royal Tiger of Bengal: his Life and Death. By J. Fayrer, M.D. (London: J. and A. Churchill.)

In this small work Dr. Fayrer gives a popular description of the zoological relationships, anatomical structure, geographical distribution and habits of the tiger. Accounts are also introduced of tiger-hunts, which well exemplify the dangers to be feared and the precautions to be taken in the pursuit of that large game, which even under the most favourable circumstances cannot be followed without a great amount of risk. The author's considerable Indian experience gives great weight to his opinions on many of these points, especially with reference to the nature of the wounds inflicted by the enraged creature.

Anatomically Dr. Fayrer brings to our notice a point in the disposition of the claw-bearing or ungual phalanges of the digits in the cat-tribe, which is not without interest. In the fore-limbs, as is well known, these bones, when the claws are fully retracted, bend extremely backwards in order to allow of the claws themselves being protected during progression. To so great an extent is this retraction carried, according to Prof. Owen, that the bone passes back to the side of the second phalanx in the same way that the blade of a clasp-knife may be said to do the same with reference to each lateral portion of the handle. In the hind limb of the tiger, Prof. Owen remarks that they are retracted in a different direction, "viz., directly upon, not by the sides of the second phalanges, and the elastic ligaments are differently disposed." Dr. Fayrer finds that in the smaller Felidæ, as the Ocelot, the hind claws are constructed and retracted on exactly the same principle as the fore. Such being the case, either the tiger differs from its smaller congeners, or Prof. Owen is wrong. Till Dr. Fayrer proves the latter, we prefer to assume that the former is the case.

"Contrary to custom, I propose to give him (the tiger) precedence of the lion. He is generally described as inferior, though nearly equal, to the so-called king of beasts; but in size, strength, activity, and beauty he really surpasses him; and therefore, though he may neither be so courageous nor so dignified, he is entitled to the first place—at all events in India." Thus says our author, and many of his descriptions fully exemplify all the animal's best points. Nevertheless, though he may be slightly greater in length, and is perhaps more active, we considerably doubt his greater strength, and as the work before us fully proves, we cannot say of him as a recent writer tells us of the lion, that "it should always be recollected, before meddling with lions, that if you do come to close quarters with them death is the probable result," the tiger having a much less dignified habit, an example or two of which we quote with reference to a case in the Madras Presidency, where a sportsman wounded the creature more than once. "It charged and seized him by the loins on one side, gave him a fierce shake or two, dropped him, and then seized him on the other side, repeated the shaking and again dropping, left him and disappeared." In a second instance a military man, "a most distinguished soldier and sportsman, when following a wounded tiger on foot in the long grass, was suddenly seized and carried off by the animal he was seeking. He managed, however, to effect his escape without having received any serious injury, and rejoined his companions, who had deemed him lost."

When so acute an observer as the late Mr. Edward Blyth, with his great experience, expresses uncertainty as to whether the lion or the tiger is the larger animal, we may be certain that there is no great difference either way. Dr. Fayrer tells us, "I have been informed by Indian sportsmen of reliability, that they have seen and killed tigers over twelve feet in length." In none of the special instances he mentions, in which careful measurements were made, did the length exceed ten feet by more than an inch. We quite coincide with the author in looking with doubt on Buffon's statement that one has attained the length of fifteen feet.

For further information on the above and kindred points with reference to the Royal Tiger of Bengal, we cannot do better than recommend the reader to glance through the small work under review.

An Introduction to Animal Physiology. By E. Tulley Newton, F.G.S. (Mumby's "Science and Art Department" series of Text Books.)

In more than one of the Science Primers which we have lately had occasion to look through and notice, it has been painfully apparent that the author is not nearly so well grounded in the subject he is endeavouring to teach as even some of his probable pupils. Some write on human physiology without having studied human anatomy; others even do not know their physiology. The author of the work before us is not one of these. It is accurate, and therefore reliable. The descriptions are precise and clear. The limits of space within which the author is confined have, in some of his descriptions, made it necessary for him to sacrifice clearness to a certain extent, but this cannot be avoided. A novel feature of the work is the addition to each chapter of a practical section, in which directions are fully given for study, by the student himself, of the more simple physiological and anatomical points referred to. These directions are particularly clear, and if carefully worked out by everyone who reads the book, will be found to lead to a sound knowledge of the first principles of physiological science. The illustrations, which are numerous, though mostly to be found elsewhere, are well selected, and sufficiently large to be distinct.

Abstracts and Results of Magnetical and Meteorological Observations at the Magnetic Observatory, Toronto, Canada, from 1841 *to* 1871. (Toronto, 1875).

In this thick pamphlet of 249 pages, Professor Kingston gives the results of an elaborate, able, and discriminative discussion of the magnetical and meteorological observations made at Toronto during the thirty-one years ending with 1871, in a series of fifty-one tables. To these are appended the daily observations from January 1863 to December 1871. While all the results of the observations, devised and carried out with so much care, and extending over so long a period, are of very great value, we would point to the wind observations as regards the diurnal changes, but particularly in their relations to differences of temperature, pressure, humidity, and cloud, and to light, moderate, and heavy falls of rain and snow respectively, as affording, from the fulness and originality with which they are discussed, much valuable information on many intricate points which it would be difficult if not impossible to find elsewhere. The influence of Lake Ontario is seen in the diurnal changes of the wind, which in July is nearly S. from 10 A.M. to 3 P.M., W. at 5 P.M., nearly N. at midnight, about which it remains till 9 A.M., when it rapidly shifts to S.W., and ultimately to S. at 10 A.M. From October to March, when storms are most frequent, the greatest depression of the barometer and increase of vapour occur with winds from N.E. to S.S.E., and the greatest rise of the barometer and diminution of vapour with winds from W. to N.N.W. On the other hand, in summer the greatest depression of the barometer occurs with winds from E.N.E. to E.S.E., but the greatest increase of vapour with winds from E.S.E. to S.S.W. Most of the light falls of rain occur with winds from N.E. by S. to W., and of snow with winds from S.W. by N. to N.E.; most of the moderate falls of rain with winds from N.E. to S.S.W., and of snow with winds from N.N.W. to S.E.; and most of the heavy falls of rain with winds from N.E. to S.S.E., and of snow from N. to E.S.E. The important bearing of these facts on the question of North American storms as well as on the climate of no inconsiderable portion of that continent is evident. Tables II. and XX. giving by interpolation-formulæ the mean temperatures and mean pressures of different days of the year, while of very slight scientific value, may be found to be useful in a meteorological office, but a simpler and in everyway more preferable table of normal daily values for pressure and temperature could be constructed from the arithmetic means of the thirty-one years' observations treated by Bloxam's method of averages.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

"Tone" and "Overtone"

In the very favourable estimate of the work I have done in my translation of Helmholtz, in your number for Sept. 23, I am taken rather severely to task for my use of "Sensations of *Tone*" on my title-page, and my refusal to use the expression *overtones* in the body of the work. The title was long a matter of anxious consideration to me, and I have not yet seen my way to improving it. True, practical musicians, physiologists, and artists have each their own, very different, technical meanings for *tone*. The two last generally use it without an article, and in the singular; but musicians are accustomed to speak of "*a* tone," or of *several* tones, when they allude to musical intervals. In common speech, however, all three agree with the outside world in speaking of a "loud and soft, gentle and angry *tone* of voice," of a "fine-*toned* instrument," of the "splendid or miserable *tone* produced by a violinist," of the "magnificent *tones* of the organ." That is, we are all accustomed to use *tone*, as I have done on my title, for "a musical quality of sound." I know no other single word in English which expresses the same conception. In the original German, Prof. Helmholtz (and after him Prof. Tyndall) endeavours to use *tone* for a "simple tone" only. Neither have contrived to be consistent in so doing. I have had to correct the text several times in my translation on this very point, and instead of using *tone* for "simple tone" only, which is a new conception, and *clang* (in English, a *din*) for "compound musical tone," which is also a new and not an easy conception, I have invariably used the word *tone* (except when distinguished by a capital letter—thus, *Tone*, for the interval) in the usual general sense of the word, and distinguished the particular cases by the prefix "simple" or "compound." It seems to me that this is not so much "a little waywardness" on my part, as a desire for scientific accuracy.

As to "overtones," it is well known to those who, like my reviewer, are acquainted with the work in the original, that Helmholtz's expression "Obertöne" is a mere contraction for "Obertheiltöne" or "Oberparzialtöne," both of which terms he not unfrequently uses, and these are literally rendered by my "upper partial tones." Waiving my strong linguistic objection to the term "overtones" as an English word, my scientific justification for not using it in my translation must be sought for in the fact that even the German "Obertöne" has led Prof. Helmholtz himself not unfrequently to its inaccurate use for "partial tones" simply, including the lowest partial tone, which the word was especially invented to exclude. Singularly enough, even my reviewer has many times fallen into the same error (NATURE, p. 451, col. 2) in speaking of the "overtones" of a pianoforte string. Thus he says, "the first six overtones are all audible," which is not correct; but he means "the *lowest* partial tone and first *five* of the *upper* partial tones," or briefly "the first six partial tones," which *is* correct. Again, he says, "the seventh and ninth (overtone) which are *inharmonious*, &c., which is not correct, for the *seventh* and *ninth overtones* are the *eighth* and *tenth* partial tones, and are perfectly harmonious; but he meant the seventh and ninth partial tones. Again, he cites from p. 126 of my translation, the relative force of the first six "partial tones," as they are there called, but refers the table to the first six "*over*tones," which is altogether incorrect. Now if such men as Helmholtz, who invented the term, and as my reviewer, who uses it familiarly, can be led by it into what with them are mere inaccuracies of *expression*, must we not look to the utmost confusion of *thought* among persons to whom the whole subject is new, and who employ the term with a very vague or loose conception of its meaning? In point of fact, many such cases have come to my notice. Hence, again, I cannot agree to think that my deliberate rejection of the word "overtones" is "the chief fault" or "a blot on the translation," but rather submit that it is a consistent endeavour to attain scientific accuracy of expression, and avoid confusion of thought.

I thank the reviewer for his generally favourable estimate, gladly accepting his rectification of the accidental Germanism "the musically beautiful" for "the beautiful in music," and I apologise for the length of this communication on the ground that it is not a merely personal vindication,

Sept. 25 ALEXANDER J. ELLIS

Colours of Heated Metals

I have just watched the casting in gun-metal, in an engineering establishment in this town, of what is intended to be the rudder-post of a large vessel, which when completed will weigh about three tons. As the casting was a simple one, it was accomplished very quickly, and as the contents of the huge four-ton ladle were emptied into the mould, the dazzling stream of the metal flowed in a large volume over its lip. Brilliantly glossy it appeared as it broke through the folds of thin dross with which its surface was encrusted; and this it did at the lip of the vessel, while fold after fold of the encrusting pellicle was swept down the stream, and left behind it a straight or ragged edge of the thin film, from underneath which the metal welled out for a moment with an appearance on the surface of perfectly transparent purity. The appearance was a deception arising from the strong bluish-green colour of the light emitted by the pure surface of the metal, which I have never seen exhibited under similar circumstances by melted iron or steel. It extended also for only a short distance from the encrusting edge, the green colour soon passing into white, or paler green, where exposure to the air enveloped the metal again in a rapidly increasing film of oxides that tarnish its surface and render the stream white, or nearly so, in every part, excepting in a bluish-green ring, or border where the fresh metal made its appearance, and flowed over in a beautifully coloured stream from the mouth of the ladle. The strongest patches of the colour there were transient, the film of oxide apparently soon thickening enough to eclipse it, and by connecting itself to the broken edge of the thin film in the pot to tear away another fold, when the characteristic greenish glow of the metal immediately presented itself along the freshly-broken edge. I had watched and thus interpreted this beautifully varied play of natural colours in the molten stream for some time before it occurred to me that the peculiar hue of the freshly-exposed surface of the metal, glowing as it does with the brightness of what in the black film of oxide appears as white heat, is no other than the very colour of the heated metal which the theory of exchanges would lead us to expect. For as the colour of gun-metal in a cold state is yellow, the selective absorption of its surface in that condition must be exercised chiefly upon rays occupying the blue portion of the spectrum, and consequently in the heated state these rays are emitted in excess; or if the heat is sufficiently intense to produce them largely, as in the melted metal, where the thin films of oxide on its surface glow with perfect whiteness, the metal itself must shine with bluish, or it may be with geeenish-blue light, if the heat is only high enough to make the excess of green rays very strongly visible. If this should be, as I suppose, the real explanation of the very curious appearance of depth of a certain tint of colour, contrasting strongly in some parts of the melted stream by its greenish hue with the surrounding redder lights, according as the natural tinted appearance of the vivid metal is effaced or diluted by the floating films of white-hot oxides in lines and parts of the stream depending on the surface-flow, and suggesting in some degree the idea of a transparent cascade, and even from its colour of a waterfall, the process often repeated in large foundries of running gun-metal into large castings presents an instance of well-defined action of the law of exchanges which must be constantly witnessed and noted inquiringly by daily observers, and which certainly presents, if a different and more natural explanation can be given of its origin, to eyes unaccustomed and unprepared to receive it, a somewhat surprising and otherwise unaccountable appearance. In gun-metal, when the proportion of zinc introduced is very small, the coating of the melted surface by copper oxide is comparatively slow, and in melted brass it might not be possible, from the rapid oxidation of zinc upon the surface, successfully to observe the same phenomenon. In order to render melted copper fluid enough for casting, a small proportion of alloy sufficient to give it almost the colour of brass is required to be mixed with it, and large pourings of the pure metal cannot commonly be made; but perhaps in small castings of this metal, and probably also in those of gold, opportunities would present themselves similar to that which I have here attempted to describe, of verifying the same general law of radiation connecting together the qualities of luminosity and absorption in the surfaces of highly coloured metals.

Newcastle-on-Tyne, Sept. 20 A. S. HERSCHEL

Changes of Level in the Island of Savaii

WHILE feeling some diffidence about setting myself in opposition to so careful an observer as the Rev. S. J. Whitmee (NATURE vol. xii., p. 291), I cannot allow his statements in regard to changes of level in the island of Savaii, Samoan group, to pass altogether unchallenged. In the month of June 1874 I spent some weeks on the island, during which time I travelled around nearly the whole of it on foot. Though not a scientific observer, I was on the look-out for indications of change of level along the coast, and it is my decided opinion that such indications are quite as little apparent in Savaii as in Upolu. Mr. Whitmee, whom I had the pleasure of meeting on the island, directed my attention to what he believed to be a line of upheaved cliffs a couple of hundred yards back from the sea, near Tufu, on the south side of the island. On examining the place, after parting from Mr. Whitmee, I particularly observed that the floor of volcanic rock at the base of the cliffs bore exactly the appearance of lava that had cooled in the open air. The creases and ripples left on the surface of the lava in cooling were distinctly visible, which could not have been the case if the rock had ever been exposed to the action of the waves. No doubt was left on my mind that the floor of volcanic rock between the base of the cliffs and the sea was at one time on a level with the top of the cliffs, and that it had broken away and sunk several feet, from some cause which I do not attempt to explain.

I brought away the impression that Savaii was at one time much more fully supplied with barrier reefs than at present, and that recent lava-flows had extended the island out beyond the reef. So far as my observations extended, where reefs do exist they are terminated by points or capes of volcanic rock, looking as if the lava had overflowed and cut off the reef.

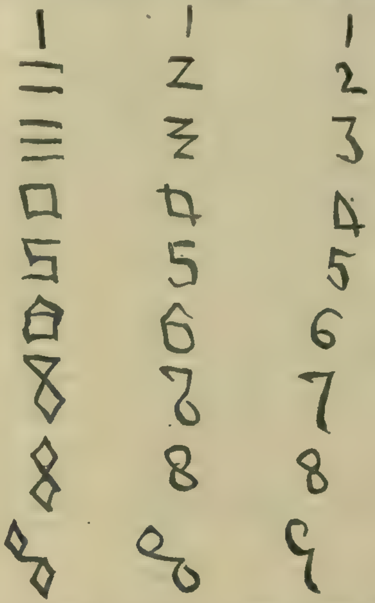
One circumstance almost, if not quite, fatal to the theory that Savaii has been upheaved in whole or in part in recent times, is that nowhere are there any signs of coral *in situ* above the sea-level. In this respect it is very different from the island of Rarotonga, in the Hervey group, which has most unquestionably been upheaved several feet, at least on the south side. There the barrier reef is altogether out of water, and what was once the enclosed lagoon is in some places dry land.

In regard to the absence of barrier reefs in front of lava-flows, I venture to suggest that it is more likely to be caused by the depth of the water or by the recency of the lava-flow than by any effect of existing submarine volcanic action on the coral insect.

San Francisco, Sept. 7 RICHARD WEBB

Origin of the Numerals

HAVING never met with any explanation of the origin of the numerals, or rather of the figures symbolising them, perhaps I am right in supposing that nothing satisfactory is known of it. In that case the following may be interesting to your readers. The first column contains the original figures, each containing as many lines as the number which it is intended to represent. The other columns show the transitions likely to result from quick writing.



W. DONISTHORPE

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Pugnacity of Rabbits and Hares

I HAVE occasion just now to keep over thirty Himalayan rabbits in an outhouse. A short time ago it was observed that some of these rabbits had been attacked and slightly bitten by rats. Next day the person who feeds the rabbits observed, upon entering the outhouse, that nearly all the inmates were congregated in one corner, and upon going to ascertain the cause, found one rat dead and another so much injured that it could scarcely run. Both rats were of an unusually large size, and their bodies were much mangled by the rabbits' teeth.

I never before knew that domestic rabbits would fight with any carnivorous antagonist. That wild rabbits never do so I infer from having several times seen ferrets turn out, from the most crowded burrow in a warren, young stoats and weasels not more than four inches long.

It is evident that the show-fight instinct cannot have been developed in Himalayan rabbits by means of natural selection, but it is no less evident that if it ever arose in wild rabbits it would be preserved and intensified by such means. And in this connection I should like to ask any of your readers who may be able to supply information upon the point, whether there is any difference between the hares of Great Britain and those of the Continent with regard to pugnacity. I have been assured by Germans that in their country a hare will fight a good-sized dog rather than run, and that it is dangerous to handle a wounded individual. I do not know, however, whether or not to trust these statements, and as there appear to be very few examples of local varieties of instincts, it is desirable that anyone who can should either confirm or deny this curious instance.

Dunskaith, Ross-shire GEORGE J. ROMANES

OUR ASTRONOMICAL COLUMN

"35 CAMELOPARDI," B.A.C. 1924.—The principal component of this double star is not included either amongst the certain or suspected variables in Professor Schönfeld's last catalogue, but there would appear to be sufficient evidence of change to justify its being placed in the former class. Variability was suspected by the Baron Dembowski from his own estimates of magnitude 1865-

68 (A.N. 1810), and the following are almost decisive of fluctuation through about two magnitudes, so that at times the star will be visible to the naked eye, and at others fairly beyond unassisted vision.

As lower estimates we have Argelander 1842 January 25—8 mag., and Radcliffe Obs. 1870 February 22—7·5 mag.

As higher estimates we find, Flamsteed, 1696 January—5½, Lalande (in Fedorenko's Catalogue), 1790 February—5·6, Dembowski, 1868 February 2—5·5, and Radcliffe Obs., 1872 March 9—6·0.

It does not occur in the *Uranometria*, but is B.A.C. 1924, and there very properly removed from Camelopardus, to which it could only have been originally assigned by a mistake. It belongs to Auriga, though it is hardly, as the Bedford *Cycle* tells us, "in the Waggoner's eye."

The Double Star Σ 2120.—M. Camille Flammarion sends us some remarks on this object, to which allusion was made in Nature, vol. xi. p. 147. Identifying it with No. 89 of Sir W. Herschel's Class III., M. Flammarion thinks the early observation tends to establish the binary character of the star, notwithstanding the measures from 1829 to 1873 may be represented by rectilinear motion. We shall revert to this subject next week.

The Minor Planets.—The elements of No. 148 have been calculated by M. Bossert and Herr V. Knorre; the orbit is one of the most inclined to the ecliptic (26°).—No. 136, Austria, was recovered at the Observatory of Berlin on the 6th of the present month. Dike and Camilla, with one or two others, are still adrift.

The August Meteors.—As previously stated, the systematic course of observation of the meteors of the August period, organised by the French Scientific Association, has this year been attended with considerable success, the atmospheric conditions on the nights of the 9th, 10th, and 11th having been as favourable as possible at many of the stations. The greatest number was observed during the night between the 10th and 11th, but this number varies much in the different accounts so far published by M. Leverrier. The Lisbon observers would appear to have recorded the greatest number, 1,227 meteors having been noted between 10h. and 15h. 25m., when the sky clouded. A table of more than forty tracks, exactly noted, appears in the Paris "Bulletin International" of Sept. 23, the co-ordinates of the points of commencement and extinction being expressed in right ascension and declination, with the corresponding mean times. At Avignon, on the same night, 858 meteors were recorded between 8h. 35m. and 15h. 40m. At Bordeaux M. Lespiault remarked that four-fifths of the meteors seen were Perseids, generally very small, though in a few cases they had considerable brightness and left trains. At Dijon, on a mean of the three nights' observations, the radiant was fixed approximately in R.A. 37°, and polar distance 45°, and in addition to this point, two secondary radiants were detected, one in R.A. 320°·4, N.P.D. 91°·8, and the other in R.A. 331°·0, and N.P.D. 90°·0. With respect to these it is remarked that although, by the means, these coordinates appeared to be confused together, yet for each night the points of radiation were very distinct, the meteors of the first group appearing to be directed towards the second radiant, and those of the second group towards the first. At Rouen, 500 meteor-tracks were entered upon the charts, the invariable direction being from Perseus. At the Observatory of Palermo, Prof. Tacchini and M. Delisa made numerous determinations of the position of the radiant from August 9-12 inclusive, the mean of the whole being in R.A. 2h. 50m.9, N.P.D. 36° 51′, but when the points are laid down on a chart it is seen that they are comprised in a very narrow ellipse, a circumstance to which Prof. Tacchini has already drawn attention.

M. Wolf, in reporting the results of this year's observations, considers that the phenomenon advances rapidly towards a very brilliant maximum; the next year will enable us to judge if this maximum has been attained, and it may then be possible, he thinks, to determine the period of revolution of a swarm of meteors, which, though now extended far along the orbit, still presents a very marked region of condensation. On the contrary, M. Wolf observes, the November shower has so nearly ceased, passing now almost unperceived, that it may be unnecessary to call upon observers, who have previously co-operated in this class of observations, to expose themselves again to the possible severity of the nights at that season.

THE CLINICAL LABORATORIES ANNEXED TO THE PARIS HOSPITALS

THE first and typical clinical laboratory was created at the Hôtel-Dieu, by private exertions, a very few months after the time when blood had been running so freely on the pavement of the great city. It was organised at the expense of two doctors, who had shared the disappointments and dangers of those troubled times.

Dr. Liouville, a nephew of the celebrated academician who edited for so many years the *Annals of Mathematics*, having learned by his travels, before the Franco-German war, that Prussia and other German powers had established special laboratories at Berlin and other large cities for promoting physiological researches in the Universities, resolved to introduce establishments of that description in his native land, but under a different system. He laid his ideas before Dr. Behier, one of the most popular professors of the Faculty who adhered to the scheme, and lent all his influence and patronage to bring physical and chemical instruments to the very bedside of the patients at the hospitals.

The intention of these two distinguished physicians was not only to open an institution where physiological science might be promoted as it is at Berlin and Vienna, but to place under the hands of practitioners ready means for enlarging the degree of accuracy of their diagnoses. At a moment's notice an able microscopist armed with a powerful instrument is to answer any question put for ascertaining the composition of humours, the nature of abnormal secretions, &c. A competent chemist, well acquainted with the properties of reagents, is ready to make an analysis of blood, of virus, of medicaments, of urine, of *excreta*, suspected poisonous matters, &c. The use of the spectroscope was not so general at the time as to call for the service of a spectroscopist, but the utility of the speciality even then was made apparent to MM. Behier and Liouville.

These operations can be done daily for the instruction of the students following the daily practice of the hospital.

When the patient dies, his autopsy being carefully made, it can be shown whether the diagnosis was true, or whether the fatal result was due to some uncontrollable circumstance. The unhappy inmate whom science and humanity were powerless to save, is turned into an object of instruction, so that human knowledge may be enlarged and other sufferers cured under similar circumstances. The laboratory was also open from the time of its infancy to foreign men of science or to practitioners wishing to investigate any points connected with their patient.

To the Hôtel-Dieu Laboratory was annexed a "chenil," where a number of rabbits and the like are constantly bred and kept in an excellent state of health. These animals are destined to be employed in testing the efficacy of new medicines to be tried, if proved innocuous, on the patients. In cases of poisoning, the localisation of toxic substances is ascertained, as well as the symptoms of death, and in some cases antidotes are administered for testing their restorative power. They may be considered as living instruments for exploring and extending scientifically the scope of *Pharmacology*.

The results obtained by the two learned associates were so rapid and so unquestionable, that in 1872 their laboratory at the Hôtel-Dieu was declared to be an establishment of public utility.

A few weeks afterwards the Commissioner of the Budget of the National Assembly having paid a visit to the Hôtel-Dieu, inserted in his report a clause asking support for the then existing establishment, at the expense of the Government, and the extension of the system to other Paris hospitals. A sum of 32,000 francs was voted without opposition, and three laboratories were opened, one at La Pitié, the second at the Charité, and the third at the Clinical Hospital. The reports of the *Commission de Budget* were succesively presented by M. Beulé, the ex-Minister of the Interior, and, after he had met his untimely death, by the present sub-Minister of Justice, M. Bardoux, who both of them asked for *frais de premier établissement*. A sum of 90,000 francs was voted, partly by the Versailles National Assembly and partly by the Municipal Council of Paris.

Dr. Liouville was appointed the chief of the Hôtel-Dieu Laboratory; Dr. Carnhill, an anatomist universally known by his researches on the diseases of the liver, was appointed the chief of the *La Charité* Laboratory.

In one of the first sittings of the last session the Municipal Council decided that a large pavilion on the northern part of the New Hôtel-Dieu, now building, should be reserved for the clinical laboratory. No money is to be spared in order to procure the most important instruments which can be designed for chemical or medico-physical observations, either in the way of galvanic batteries, microscopes, spectroscopes, &c. A clinical laboratory will also be established in the new hospital to be inaugurated at the end of next November, which will be one of the most extensive in Paris.

NOTE ON HÆMATITE INDIAN AXES FROM WEST VIRGINIA, U.S.A.

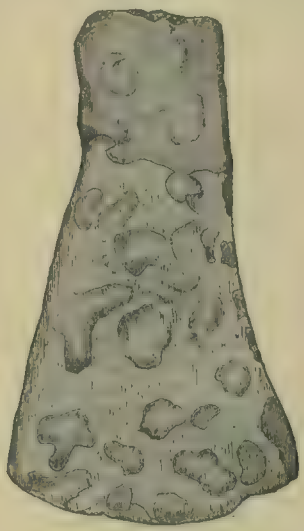
THROUGH the kindness of Horace Fisk, of Trenton, and Major Jed. Hotchkiss, of Staunton, Va., I have been able to procure two specimens of hæmatite iron ore hatchets, of aboriginal manufacture. They possess great interest from the fact of being very similar to native copper axes, characteristic of the "finds" of relics of "mound builders." The specimens, one of which is here figured, have unquestionably been hammered out cold, and shaped from a fragment of the ore, without the aid of fire in previously refining the mass. The specimen figured measures five inches and a quarter in length, by three inches in breadth at the cutting end. The opposite end is square, nearly two inches in width, and somewhat thinner than the broader portion of the implement, which is nowhere of greater thickness than one-fourth of an inch.

The entire surface still shows the hammer marks made in shaping the hatchet, even to the edge, which now shows no trace of grinding or polish; but this may have been obliterated by the rust; but I am inclined to believe from close inspection of both specimens, that the edge originally was a hammered one, and not a ground one; making the specimen more nearly allied to the "clipped" jasper hatchets than polished (ground) porphyry axes.

The accompanying specimen is four-and-a-half inches in length, by two in breadth, is nearly uniform in thickness about three-sixteenths of an inch, and has a well-defined edge, which from its slightly wavy outline, and slight variation in width, I believe to be a hammered, and not a ground or polished edge.

Two other specimens, similar to these, were found with them, and are now in the calimat of Major Hotchkiss, who informs me that the series of four were found under an uprooted tree, on an Indian trail, at the Forks of Kelley's and Rich Creek, Gauley Mt., Tayette Co., West Va.

It has been suggested that the use of hæmatite for paint among our Indians may have led to its employment for other purposes ("Flint Chips," by E. T. Stevens, p. 553), and this is no doubt true, inasmuch as small irregular fragments of this mineral were often utilised, if the shape would at all permit, as arrow heads. Among the thousands of arrow-heads gathered in New Jersey, I have not met with one of iron ore that has been worked into any of the various patterns of flint points; but from graves, associated with others, I have found fragments of the ore, and once, of native copper, of such shape and size, and so placed, that they were evidently arrow-heads.



A curious form of "relic," known here as a "plummet," occasionally occurs, made of iron-ore. One such is figured in the "American Naturalist," vol. vi., p. 643, Fig. 132. This specimen "is made of iron ore, ground down and polished until it is almost as smooth as glass." As such plummets are found in the western mounds, as well as on the surface of the ground throughout the Atlantic coast States, and are always polished, it seems fair to presume that a cutting instrument of such hard material would undoubtedly be polished and ground, if, at the time of its manufacture, grinding was known or practised among the aborigines in fashioning their various weapons and instruments.

When we consider that these iron hatchets were found in a locality once thickly populated by Indians, and probably frequently visited, if not occupied, by the mound-builders, and now yield, on search, an abundance of ordinary stone implements of every grade of workmanship and variety of pattern, it seems at least probable that the specimens in question were not fashioned at a time when the polishing and grinding of weapons was customary, but earlier, as the labour of beating so hard a material into its present shape would doubtless be supplemented by polishing, if the additional value given to an implement by the operation had been recognised.

As the writer has already endeavoured to show, through an extensive series of New Jersey specimens (NATURE, vol. xi., p. 215), that the ruder chipped implements of "our native rocks" are older than the more elaborate jasper and porphyry specimens, so I consider these hammered iron hatchets to be of an earlier age than either the polished iron plummets of the mound-builders, or ground axes of the Indians.

CHARLES C. ABBOTT

Trenton, New Jersey, U.S.A.

DOHRN ON THE ORIGIN OF THE VERTEBRATA AND ON THE PRINCIPLE OF SUCCESSION OF FUNCTIONS

THE introduction of the doctrine of Descent into the study of organic phenomena has opened the floodgates of speculation, of hypothesis, and theory. Probably, with very few exceptions, this is regarded with regret and impatience by zoologists and botanists, even though staunch Darwinian converts, who had made any name in biology in the period anterior to the publication of Mr. Darwin's work on the "Origin of Species." Those were the days of a reaction brought about by the fantastic imaginings of Oken and his school; and the naturalists brought up in those days cannot rid themselves of a dread of speculation which has become as much an organic part of their nervous systems as has the fear of precipices, bricklayers' ladders, and of the mythological personages of their childhood, to most men. It remains for the present and later generations who will be brought up, not to fear, but to use speculation, to turn fully to account the immense engine of research which Mr. Darwin has placed in their hands. We see, in fact, no reason for refusing to welcome any number of hypotheses and theories on biological topics: let every one make his suggestion—the more ingenious and original the better—and let it be taken for what it is worth. If in its author's or another naturalist's hands it should lead to the discovery of new facts—if it should in a more or less modified form be established as true—it will bring thanks and honour to its promoter. If, on the other hand, it should lead to nothing, should be tested and found neither true nor suggestive of truth, it will fall to the ground quietly enough, and do no harm to anybody. This, be it said, applies only to the publication of such hypotheses within the scientific area—a totally different and a very grave responsibility is incurred when an author represents a hypothesis as an established doctrine, and appeals to the support of an uninstructed public. The fact is that we have acquired this freedom of speculation as compared with the proscription of it in the pre-Darwinian period, through the circumstance that biological theory has passed from the theological to the scientific form. To-day—no matter who its author—a speculation as to the mode of development of this or that group of animals and the significance of this or that organ, may be verified or rejected; no one will attach undue value to it until this process has been gone through. Formerly it was not possible to test such speculations; we had in fact no link by which organic phenomena were made part of the whole series of phenomena of which science takes cognisance, and biology had no foundation in the so-called experimental sciences. Hence speculations were liable (as in theological discussion) to be launched by authorities, and to be received not as speculation, but as something like *inspiration*, by disciples; and on the other hand to be rigorously and almost puritanically tabooed by a constantly increasing number who, refusing to occupy themselves with these vain imaginings, endeavoured to keep the facts pure and undefiled, waiting for the coming of an interpreter—who was realised in Mr. Darwin. The doctrine of organic evolution as elaborated by Mr. Darwin and his immediate successors has provided us with a proper scientific framework, and we can now proceed to build on that by the legitimate methods of modern inductive science. It will be some time before biology fully emerges from its theological form; at least another generation must pass; and in the mean time we must expect the continuation of special claims on the part of authorities to advance speculative doctrines *ex cathedrâ*; and on the other hand a lingering antagonism to all speculation, even to that which makes no pretension to authority, on the part of those who have imbibed the horror of fantastic "Natur-philosophie" and of dogmatic pretensions.

To those who belong to neither of these sections, it is worth while pointing out that even the most careful observation and recording of phenomena in the absence from the observer's mind of some theory or speculation which shall, so to say, sharpen his wits and keep his eyes open, is likely to be of the very smallest value. It cannot be too strongly asserted that in observing a complicated phenomenon—such as an organic structure or series of structures—the investigator is only likely to see what he has already imagined *may be* there; the chances are greatly against his detecting an arrangement or a mode of development of which he had previously no suspicion. Though cases of unforeseen discovery do occur, yet it may be safely stated that, as far as all but the most patent and macroscopic appearances are concerned, the observations of no predecessor should be trusted by an investigator beyond the limit which is given by the hypotheses which are known to have been present to that predecessor's mind. In fact, a man can only expect to get answers from Nature to specific questions; she will not give him unsolicited information, nor make a voluntary statement, however attentive the listener. Hence the value and legitimacy of speculations, even *ad nauseam*, on such matters as the pedigree of animals and plants. When advanced, with due knowledge of ascertained facts, they suggest to the embryologist, to the palæontologist, and the anatomist, a number of possibilities which he holds before him as so many questions to be answered by the material of his studies. It is true that it is desirable in a high degree that the person who frames a hypothesis should also himself be active in using it in a practical way, and indeed if he is not, he may find no one who will take the trouble to bear it in mind. Therefore, one must admit the generosity of those who now-a-days make a present of their speculations to scientific *confrères*, and undertake the part of the profound thinker, whilst assigning to others the more practical task of verification and elaboration. For, since the days of scientific inspiration are past, but little credit will attach to the launchers of hypotheses, and more and more to those who destroy them, either by showing their error or by transubstantiating them, in demonstrating that which was supposed, actually to be. It is Darwin whose name we associate with the doctrine of evolution—not Lamarck's, nor Goethe's, nor Wells', nor Freke's.

These remarks are a necessary prelude to the consideration of the bold speculations with which Dr. Anton Dohrn, the founder of the zoological station of Naples, known also for some interesting observations on the development of Crustacea, has recently astonished the zoological world in his "Ursprung der Wirbelthiere und Princip des Functionswechsels." The necessary sequence of the general acceptance of Darwin's theory of the origin of species by descent and natural selection has been an attempt to establish the pedigree of the animal kingdom, and to indicate the degrees of consanguinity among the different members of it known to us. In the first attempts in this direction no one can doubt that errors and vagaries of all kinds must occur. It is only when naturalists have fairly set themselves to the task and made some few false starts that we can expect to see anything like a just appreciation of the methods to be pursued, of the difficulties to be encountered, and of the fallacies to be avoided. We are obliged to admit that the first attempts in the way of constructing the pedigree have been influenced, as they were likely to be, by the remnants of old notions and by the lack of a perfectly unprejudiced appreciation of the question in hand. The pamphlet of Dr. Dohrn comes opportunely enough to insist upon one or two important considerations which have been neglected; and even though, by an excess of antagonism to prevailing prejudice, Dr. Dohrn may be led to oppose exaggeration to exaggeration, we cannot the less feel that there is sound sense and truth in the general purport of his views.

In the pre-Darwinian period naturalists looked upon the series of classes and orders of the animal kingdom as a more or less branched ascending series. The effort in nearly all classifications was to distinguish the lower from the higher and to place the groups in their supposed order of merit, as competitors for the highest rank of organisation. This has led—now that Darwinism is accepted—to a tacit assumption that the order of "degree of organisation" which was worked out in the pre-Darwinian era, is necessarily the order of historical development; that consequently the lower forms of any group which are existing to day, are nearer to the ancestral forms of that group than are the more highly organised forms.

Whilst an exception has been made to this unreasoned and unchallenged assumption in favour of the parasitic forms for which the term "retrogressive development" has been coined, it does not appear to have occurred to any prominent naturalist, at any rate it has not been prominently maintained, that the "retrogressive development" which all so readily admit for parasites, may be a very general phenomenon, as widely or more widely diffused as that of "progressive development." To have insisted on this possibility even to an excess (of which more below) is the merit of Dr. Anton Dohrn. Dr. Dohrn has arrived at an appreciation of the possibilities of degradation or retrogressive development, by divesting himself of all preconceived notions and of all respect for authorities. In his pamphlet he grapples courteously, but fearlessly enough, with Von Baer, Darwin, Haeckel, Gegenbaur, and for the matter of that by implication with almost every zoologist of note.

We claim for him, first of all, full liberty to do this and to launch the hypothesis of general retrogressive development as a competitor with that of universal progressive development. It requires but a few words of explanation and an example, for which Dr. Dohrn has selected the possible relations of the Ascidians to the Vertebrata, to show that retrogressive development is not only a possibility, but *must* be going on and has been going on—on a very large scale—and in any doubtful case is as much entitled to consideration as the hypothesis of progressive development. A less important portion of the pamphlet is that which precedes the development of the author's Hypothesis of Degradation, and illustrates the application of what he calls the "principle" of the Succession of Functions. To put it in the form of a hypothesis it comes to this:—"Organs do not arise *de novo* in organisms, but are formed by the gradual change of function and accompanying change of structure of pre-existing organs." That this is true, or at any rate that it is the hypothesis which, according to the "principle of uniformity," must be preferred to its converse, namely, "that organs *are* formed *de novo*" must be admitted by everyone. In fact, most of Dr. Dohrn's readers will feel that there really is not much novelty in this proposition, since it is already involved in the doctrine of homologies to a very large extent. Dr. Dohrn admits this in his pamphlet, but we conceive that his view differs from that implied in the generally recognised doctrine of homologies, in that the latter is not absolute; it would merely assert that *many* or *some* organs do not arise *de novo*, but are formed by the gradual change of function and accompanying change of structure of pre-existing organs. Dr. Dohrn raises this into a hypothesis of *universal* application, and proposes to apply it stringently in speculations as to the genealogical relationships of organisms. He illustrates its application in an attempt to explain the genealogical affinities and mode of development of Ascidians, Amphioxus, Lampreys, and Sharks. We are very much disposed to believe that here, as in his advocacy of the hypothesis of degradation, Dr. Dohrn has grasped and emphasised a truth which has been floating before the eyes of other people but has not been appreciated at anything like its real importance by them. We believe that the hypotheses of degradation and of continued homologies put before naturalists in the present pamphlet will have a very important and powerful influence on the rapidly progressing reconstruction of the animal pedigree with which so many zoologists are busy.

At the same time it is necessary to point out that the particular speculative conclusions at which Dr. Dohrn arrives as to the new Vertebrate mouth which has replaced the ancestor's mouth as well as the new Ascidian mouth, which has done the same thing—further, the conclusion as to the secondary character of the Vertebrates' anus, and the development of Vertebrate gill-slits from segment organs and of Vertebrate limbs from annelidan gill-supports—all this and more besides is ingenious and healthy hypothesis, but has no value unless Dr. Dohrn or some one else (which is not a thing he should rely upon) will bring it to bear upon the facts and seek to establish it by new observations. We must confess that although we are inclined to entertain some of Dr. Dohrn's suggestions as hypotheses, yet we feel that he has given us rather a large supply, which, in justice to his reputation as an observer, he should hasten to balance by a fair amount of new investigation. Such a speculation as that which he gives us relative to the origin of Vertebrates, can from his hands only be regarded as a sort of programme or announcement of the work which he intends to do during the next decade at the Zoological Station. We shall look most anxiously for the first instalment of results.

Lastly, we shall not shrink from pointing out that Dr. Dohrn urges the hypothesis of degradation to a degree which would be regrettable were it quite evident that he is serious and not merely anxious to engage the attention of his reader by letting imagination have its full swing. Supposing, says Dr. Dohrn, that the Ascidians are the degenerate descendants of a half-worm- half-fish-like ancestor—and the mere consideration of their individual development is enough to make this probable—then we have to admit an amount of degeneration which covers very wide possibilities. For the compound Ascidians, with their various encrusting species, are included in the series; and, moreover, many forms which have ceased in their individual development to give any indication of the affinities which are indicated by the larvæ of other forms. If so large, so abundant, and varied a group can thus take its rise by degeneration, what is to prevent the simpler worms from having originated in the same way? Why may not the Cœlenterata have acquired histological and general simplification in a parallel manner by degeneration accompanying a fixed life? And the Protozoa, the whole series of unicellular animals, why are they not to be considered as degenerated from multicellular forms by a process of simplification? In fact, in a few sentences Dr. Dohrn suggests doubts which land him in a theory which is almost identical with that of Aristotle.

"Thus then," he says, "the animal kingdom has quite a new aspect for us when we look at it from the point of view developed in this essay. Instead of having before us a large mass of forms which from the first commencement of organic life have made little or no progress, whilst a few favoured stems have developed themselves to the highest perfection, we obtain the conception of one single stem, which bore within itself the germ of all other higher, highest but also lowest forms, whose descendants on the one hand in thought and fancy embrace the universe and recognise themselves within the universe as individualities, whilst others lead a senseless inert existence and give rise to the belief that a non-living nature might be able now or at any time to originate such things." Finally, the author argues that the development of this single stem is not to be assigned to either chance or to chemico-physical, but to an "Entwickelungs-gesetz" yet to be discovered. This, we confess, is to us a disappointing termination to a clever and spirited essay. Surely Dr. Dohrn would not expect a scientific man to understand by the word "chance" anything but a periphrasis for the operation of hidden cause. And what can he expect any law of development to be, if not an expression of the operation of chemico-physical causes?

As to the original form under which life made its first appearance, Dr. Dohrn's words would almost lead to the impression that he believes in the creation of a "type-form" something like the Cherubim, with an account of which Archdeacon Freeman favoured Section D of the British Association when it met at Exeter in 1869. His language is, however, sufficiently vague to warrant the supposition that, as an orthodox physical philosopher, he holds the doctrine of the evolution of organic forms subject to the larger doctrine of general evolution, and consequently we may suppose that he would hold that the single stem which has blossomed in man, and from which all other forms have descended by retrograde development, *did* take its origin from simple protoplasm, which had naturally been evolved from carbon compounds. If the animal pedigree did originate from these very simple beginnings, we suppose Dr. Dohrn would say that all trace of them is gone, what is simple *now* in the way of organisms is not the simplicity of the original stock, but a simplicity attained by degeneration. We do not see any reason to accept this hypothesis of *universal* degradation (man alone being excepted from its influence), any more than we can see reason to accept the competing hypothesis of *universal* progress. We are very strongly inclined to think that neither hypothesis can have the whole field to itself. We should expect to find in some directions progress, in others retrogression.

The extent to which each of these processes has gone on in past ages in connection with the family history of the animal kingdom is the great problem for zoological research.

E. R. L.

THE NEW METAL GALLIUM

THE discovery, by M. Lecoq de Boisbaudran, of a supposed new element in a blende from the Pierrefite mine in the Argeles Valley, Pyrenees, was made known n our "Notes" of last week. This element, which the discoverer proposes to name *Gallium*, has revealed itself by the following chemical reactions:—

The oxide, or possibly suboxide, is precipitated by metallic zinc from a solution containing chlorides and sulphates.

In a mixture of the chlorides of the new metal and of zinc, ammonia throws down the new element first if added n a quantity insufficient to precipitate the whole of the metals present. Nearly the whole of the gallium is thus hrown down in the first fraction.

Under conditions competent to peroxidise the new metal, the oxide is soluble in excess of ammonia.

Ammonium sulphydrate produces a precipitate insoluble n an excess of the reagent. The sulphide appears to be white.

Sulphuretted hydrogen produces a precipitate in preence of ammonium acetate and excess of acetic acid. In resence of zinc salts the new substance concentrates self in the sulphides first deposited, but six fractional recipitations were requisite to remove the greatest part f the zine sulphide. In presence of hydrochloric acid o precipitate is formed.

The oxide, like that of zinc, dissolves in excess of mmonium carbonate.

The salts of gallium are readily precipitated in the cold y barium carbonate.

The chloride may be frequently evaporated with great excess of *aqua regia* without undergoing any loss by volatilisation.

When hydrated zinc chloride containing a trace of the new substance is heated to the point when zinc oxychloride begins to form, the gallium remains in an insoluble condition, possibly as oxychloride.

The quantity of the substance procured was too small to attempt its isolation. Some drops of zinc chloride solution in which the new metal had been concentrated were examined spectroscopically by the electric spark. The spectrum is composed chiefly of a violet line about wavelength 417, and a feeble line about 404.

In his communication to the French Academy, the author states that he obtained the first indications of the new metal on Friday, Aug. 27. It is to be hoped that a good supply of the mineral will be procurable, so that the new element may be isolated, its atomic weight determined, and its reactions studied in detail. This now makes the fifth terrestrial element which the spectroscope has been instrumental in bringing to light.

R. MELDOLA

UNPUBLISHED LETTERS OF GILBERT WHITE

AT the meeting of the Norfolk and Norwich Naturalists' Society, held on the 28th inst., the secretary read an interesting series of ten unpublished letters, written by Gilbert White, of Selborne, to Robert Marsham, F.R.S., of Stratton Strawless, Norfolk, and communicated by the Rev. H. P. Marsham, great-grandson of the latter. The letters, which are dated between August 13, 1790, and June 15, 1793, are excellent examples of Gilbert White's delightfully discursive style, their contents being of a very varied nature. Mr. Marsham, to whom they were addressed, was a great planter, and communicated his experiments on growing trees to the Royal Society; the beauty and great size of the timber at Stratton bear testimony at the present day to his judgment and successful treatment. As might be expected, under these circumstances, a large portion of the correspondence is devoted to forest-trees, the love for which was shared in an almost equal degree by both correspondents. The "Indications of Spring," of which Mr. Marsham left such a remarkable register, and which have been continued by his family, with one slight interruption, from the year 1736 to the present time (see "Philosophical Transactions" for 1789, and the "Transactions" of this Society for 1874-5), of course form an annual topic, as well as the rainfall; but perhaps the most valuable part of the correspondence is the gossip about birds, some of which is of very great interest. On the 30th October, 1792, Marsham writes to White: "My man has just shot me a bird which was flying about my house; I am confident I have never seen its likeness before." On reference to his Willoughby, he declares it to be "the Wall-creeper, or Spider-catcher," and a description, endorsed by him on one of White's letters, as well as a manuscript note in his copy of Willoughby's "Ornithology," still in the possession of the Marsham family, places it beyond doubt that the bird was a veritable *Tichodroma muraria.* White, after saying he is persuaded that the bird is the "very *Certhia muraria,*" continues: "You will have the satisfaction of introducing a new bird of which future ornithologists will say, 'Found at Stratton, in Norfolk, by that painful and accurate naturalist, Robert Marsham, Esq.,'"—a prophesy which, after an interval of eighty-two years, will at length be fulfilled. Nearly a whole letter is devoted to an extract from an unpublished "Natural History of Gibraltar," by Gilbert White's brother, the Rev. John White, who resided many years on the "Rock." By this it is shown that John White, who went to reside there in 1756, soon discovered the Crag Swallow

(*Cotyle rupestris*) to be distinct from the Sand Martin, for which it was then mistaken. He gives an interesting account of its habits, and names it *Hirundo hyemalis*, from its great abundance at Gibraltar in the winter months. The last letter of the series, dated June 15, 1793, has a special interest attached to it from the fact that it was written only eleven days before the death of this estimable man and ardent naturalist. The whole of this interesting series will be published in the Transactions of the Society, and it is hoped, through the kindness of Prof. Bell, in whose hands they now are, that Marsham's letters to White may be added.

NOTES

DURING the last week there has been a goodly talk about education, and Mr. Cross has come to the front in a most unexpected manner, while the modern English Cardinal has been acting as his foil. Cambridge, too, in the shape of Mr. James Stuart, has been active at Nottingham, and the world thinks that the University is active. The truth is, however, that the University is too poor to do anything, and that the Colleges are simply looking on while a private benefactor is providing both with those means of teaching which third-rate institutions on the Continent have possessed to a greater or less extent any time during the present century. Mr. Cross not only foreshadows compulsion, but he shows that we have now a Minister who knows the difference between Education and Instruction. "It is not mere book learning that I am talking of. That is not the object of these schools. It is the school discipline, the training of the mind of the child, the teaching him how to teach himself, the self-control and the self-respect which he gets at school, which do more for him than all the book learning that you put into his head." The Cardinal, on the other hand, defines "Secular Education" as "secular knowledge," and then adds: "Education means the full possession and understanding and enjoyment of the inheritance of faith, which the child has by virtue of his regeneration in baptism." It is clear that the Cardinal, if he means anything, confounds instruction with education as successfully as ninety-nine out of every hundred who talk on the subject confound education with instruction.

AT a meeting of the Entomological Club of the American Association for the Advancement of Science, Mr. C. V. Riley, the secretary, read a paper on "Locusts as Food," in which he gave his own experience in cooking and eating them. On one occasion he ate nothing else for a whole day. He found them to have an agreeable nutty flavour, and especially recommended them deprived of their legs and wing-cases, and fried in butter, and also spoke very highly of a soup made from them. He referred to John the Baptist, who had often been pitied for the scantiness of his fare, locusts and wild honey, and expressed his opinion that he was rather to be envied than otherwise. The writer regarded it as absurd that parties should actually die of starvation, as some had done in the districts where this locust plague had prevailed, while surrounded by such an abundance of nutritious and palatable food.

FROM different settlements on the West Coast of Africa young living gorillas have several times been shipped for Europe under auspices apparently the most favourable. On one occasion, about six years ago, a Dutch merchant at St. Paul de Loanda took the trouble to keep a young male in company with a black boy for some considerable time on the coast, and when the two had become good friends, took passages for them both to Holland. The animal only survived a fortnight from the date of its embarcation, dying rather suddenly, as most others seem to have done, from a kind of depression or home-sickness, not from any well-marked disease. No gorilla, exported as such, has reached Europe alive. Quite recently, within the last month or so, one destined for Hamburg arrived within two days of its journey's end, when it shared the fate of its predecessors. This specimen was, immediately after its death, placed into spirit, and will, we believe, form the subject of a monograph by Dr. Bolau, of the Zoological Museum of Hamburg, from whom we may expect the settlement of several important and doubtful points in the anatomy of the greatest of the anthropoid apes. In about the year 1852, in one of Wombwell's travelling menageries, there was exhibited for some months a monkey very like a chimpanzee. The animal was expert at tricks, and was clad in a grotesque costume. From a daguerreotype photograph in the possession of Mr. A. D. Bartlett, resident superintendent of the Zoological Gardens in Regent's Park, that gentleman was enabled to identify the specimen as one of a young gorilla, and not a chimpanzee. Its face was dark, its arms and legs proportionately larger, its ears very much smaller, and the distance between the eyes greater than in the chimpanzee. A still more interesting instance of the same kind has, however, recently occurred. For the last two years there has been a female "chimpanzee" at the Zoological Gardens at Dresden, named Mafota, which has attracted considerable atention. She was purchased by Herr Schöpff, the Director of the Dresden Gardens, in a very unpromising condition, being much denuded of hair, and covered with an unhealthy skin eruption. Since the animal has been under Herr Schöpff's skilful care, it has become quite a different creature. It has grown very rapidly; surprisingly so. The hair now forms an abundant covering, and the skin is in a perfectly healthy condition. It is quite tame with its keepers, whose boots it is in the habit of taking off and replacing for the amusement of visitors. It performs many other tricks, showing great intelligence. Herr Carl Nissle, an artist, we believe, whilst studying the figure and movements of Mafota, became rapidly impressed with the idea that she is not a chimpanzee at all. Her great size, the numerous black spots on the naked skin of the face, which in the chimpanzee is simply flesh-colour, the black instead of pink hands, the slight webbing between the fingers, and the different expression, with a broader nose, all led him to the conviction that she is a gorilla. He carefully studied the stuffed specimens of the gorilla and chimpanzee, both at Berlin and Lubeck, and, what is more, has had the opportunity of seeing the new Hamburg spirit specimen above referred to. These all confirmed his surmise, towards the complete verification of which we have the affirmative opinion of Prof. R. Hartmann, prosector to the Anatomical Museum of Berlin. So there is strong reason for the belief that Mafota is a gorilla, the first living specimen recognised as such in this continent.

THE following are the hours of the various Introductory Lectures at the London Medical Schools, which will be delivered to-morrow (Oct. 1st), with the names of the respective lecturers:—

HOSPITAL.	LECTURER.	HOUR.
Charing Cross	Mr. Fairlie Clarke	4 P.M.
St. George's	Dr. Barnes	4 ,,
Guy's	Dr. Stevenson	2 ,,
King's College	Dr. Curnow	4 ,,
London	Dr. B. Woodman	3 ,,
St. Mary's	Dr. Randall	3·30
Middlesex	Mr. Lowne	3 ,,
St. Thomas's	Dr. Payne	3 ,,
University College	Dr. Corfield	3 ,,
Westminster	Mr. R. Davy	3 ,,

DR. JAMES BELL PETTIGREW, F.R.S., Lecturer on the Institutes of Medicine at the Royal College of Surgeons, Edinburgh has been appointed to the Chair of Medicine in the University o St. Andrews, vacant by the death of the late Dr. Oswald Hom Bell.

THE following is a list of candidates who have been successfu in obtaining Royal Exhibitions of 50*l.* per annum each for thre years, and free admission to the course of instruction at the Royal School of Mines, London, and the Royal College of Science in Dublin :—1. School of Mines : John Gray, 21, engineer, Strichen, N.B. ; Frederick G. Mills, 14, student, London ; Thomas E. Holgate, 20, farmer, Blackburn. 2. College of Science : C. C. Hutchinson, 21, engineer, Leeds ; Henry Hatfield, 20, student, Stockport ; Thomas Whittaker, 18, clerk, Accrington.

THE term of office of the present Lord Rector of Aberdeen University—Professor Huxley—having nearly expired, the students are already looking out for a successor. Mr. M. E. Grant Duff, M.P., Dr. W. B. Carpenter, Mr. Robert Lowe, and Dr. Alexander Russel, editor of the *Scotsman*, are proposed for election. A report in the *Times* states that the feeling of the majority seems to be in favour of Dr. Carpenter.

THE preliminary North-west African Expedition is expected to leave England for the coast of Africa early in November. General Sir Arthur Cotton and several scientific gentlemen are expected to accompany it. The object in view is to make a survey of the coast of Africa opposite the Canary Islands for the purpose of finding a suitable position for a harbour and commercial and missionary station ; to enter into commercial arrangements with the native tribes, and to inquire into their present means of commerce, and the resources of the countries through which it is proposed to pass. To examine as far as practicable the sand bar across the mouth of the River Belta, which it is supposed keeps back the waters of the Atlantic Ocean from flowing into the dry bed of the ancient inland sea, to obtain levels and other necessary information. Mr. Mackenzie, the director of the party, expects to get the friendly support of the most powerful chief of the tribes on the north-west coast of Africa.

THE celebration of the fiftieth anniversary of the opening of the first railway between Stockport and Darlington is attracting the notice of the French papers. A curious fact connected with French railways is that Baron Charles Dupin, who published his celebrated work on Great Britain in 1826, described railways at full length, but abstained from saying a word about motive-power. Baron Dupin, a great geometer and mechanician, declared to the Institute that locomotives could never move, owing to the weakness of their hold on the rails, and that the use of horses could not be dispensed with. Baron Charles Dupin's reputation was so great that the truth of the statement was taken for granted, and in the École des Ponts et Chaussées, the public institution where State engineers are educated at the expense of the Government, in a course of lectures given after 1830, it was said that horses could never be dispensed with. The advantages of locomotion were lectured upon in a free institution which was opened at that time, called the École Centrale des Arts et Manufactures. The professor was the celebrated railway engineer, Perdonnet. Arago was opposed to the boring of tunnels as endangering the health of travellers, owing to the great cold which he anticipated would be felt.

M. LEVERRIER has addressed a circular to the Presidents of the Meteorological Commissions of the departments with reference to the Meteorological Atlas in course of publication for the years 1872, 1873, and 1874. It is intended that this important work shall contain instructions relative to meteorological observations and tables for their reduction : a discussion of thunderstorms which have occurred in the different river-basins as well as over France generally ; a *résumé* of the observations made during the three years at the departmental stations ; hail charts ; the rainfall for the whole of France, by M. Belgrand ; and lastly, a series of memoirs on special subjects by French and foreign meteorologists. The price for the large or folio volume will be only eight shillings, representing the price of paper and printing, the printing being undertaken by the Government, and the compilation having been done by the Meteorological Service at the Observatory. The number of copies printed being necessarily limited, persons wishing to purchase the work are required to send a money order to the Secretary of the Association Française, 11, Quai Voltaire, Paris.

DR. GUSTAVUS HINRICHS, Director of the Laboratory of the Iowa State University, Iowa city, has issued a circular, dated August 1875, with the view of organising a system of rainfall observation for the whole of the State of Iowa. He is confident of a start with one rain-gauge in each county of the State, and hopes in a few years to secure the erection of four or five gauges in each county. Printed forms on addressed postal cards will be issued to the observers, who are requested to mail them on the 1st, 11th, and 21st of each month. Thrice a month Dr. Hinrichs will prepare a statement of the rainfall of Iowa for the corresponding ten days, comparing it at the same time with past averages, and forward it to the daily press for publication. Other States will doubtless soon follow the example.

THE Upsala Observatory has published a Circular (No. 6) giving an elaborate discussion by Dr. Cronwall, of the observations made over Sweden to determine the annual periods of the duration of ice. The six coloured maps, which illustrate the paper, showing, by lines passing through equal times and periods, the beginning, end, and number of days' continuance of the ice over the different districts of the country during the winters of 1871-72 and 1872-73, are valuable contributions to the climatology of Sweden. Their great value lies in illustrating in a precise as well as striking manner the influence of its adjoining seas, its lakes, its mountains and lesser elevations, and latitude, in determining the times of occurrence and termination of this element of the climate of Sweden. These discussions, begun by Dr. Hildebrandsson for the winter of 1870-71, cannot fail to be of great benefit to agricultural and other public interests.

SINCE our last issue we have received telegraphic intelligence of frightful floods and consequent loss of property in Texas. At Indianola the storm began on the 15th. The east wind which prevailed next morning increased to a gale. The water soon became six feet deep in the streets. On the 17th the wind veered to the north-west. The waves became chopped. The houses were washed away or tumbled down. Toward the morning of the 18th the wind lulled and the water receded ; wind veered to the north. When daylight broke an awful destruction became visible. The town could not be recognised. The ruin was almost total. Seventy bodies were found in a brief period and buried. Men and women were discovered who had floated on doors or anything obtainable. Some were imprisoned beneath roofs. Hundreds had miraculous escapes. The loss of life may reach 200. Every business house but five has been destroyed. Every pilot but one has been drowned. The city of Sabine has been submerged and greatly damaged, but without loss of life. Matagorda, at the entrance of Matagorda Bay, has been swept away ; but two houses are standing. Cedar Lake is also destroyed. All the inhabitants are reported lost at East Bay. In a village containing twenty-eight people, all but five are lost.

A CORRESPONDENT of the *Daily News*, writing from Christiania, says : "I translate the following from the *Finmarken-post*, a newspaper published in Europe's northernmost city—Hammerfest :—'On the 3rd instant arrived at Hammerfest the schooner *Regina*, Capt. Gundersen, belonging to the firm of O. J. Finckenhagen, from a voyage in the Arctic regions and the north coast of Nova Zembla. Capt. Gundersen discovered in Nova Zembla a journal, kept by the Dutch Arctic voyager, Barent, apparently giving an account of his doings from the 1st of June to the 29th August, 1580, as far as Capt. Gundersen was able to make out, being unacquainted with Dutch and Dutch writing of 300 years ago. The paper is in excellent preservation, and the writing distinct. Barent passed the winter 1596-97 in the Arctic regions. This journal, therefore, relating presumably to 1580, will give no information of his stay, but will, nevertheless, be of great interest.'"

We learn from *Harper's Weekly* that the Kirtland School of Natural Sciences, established in Cleveland, Ohio, for summer instruction in natural history, concluded its course on the 9th of August last. The school consisted of twenty members, of whom thirteen were ladies, and lasted for five weeks, during which time gratuitous instruction was given by lectures and otherwise, and short excursions were made in connection with the subjects of study. Dr. Newberry, Prof. Theodore B. Comstock, Prof. Albert Tuttle, and Dr. William K. Brooks were the instructors. The operations of the school were mainly conducted by Prof. Comstock. Facilities were extended by railroad and steamboat companies in the transportation of the school and in various interesting excursions.

In a recent number of the *Philadelphia American Times*, Dr. W. W. Keen proposes the employment of a solution of chloral as a preservative for objects of anatomy and natural history, its special advantage being said to be that the colour of objects is perfectly preserved, and all the parts retain their natural consistency, at the same time that no special precaution is necessary in stoppering the bottles containing the preparations. It is used by injecting it into the blood-vessels, or by immersion.

In a recent number of the *Journal de la Société centrale d'Horticulture de France*, there is an article by M. Ch. Royer, "On the Causes of the Sleep of Flowers." The sleep of flowers has been attributed to various causes, including heat, light, moisture, dilatation of the epidermis of the inside of the perianth, contraction of the outside of the perianth, &c. The writer of the article in question endeavours to prove that expansion of the flowers in the morning is due to a turgescence of the parenchyma of the flower, brought about by heat, certainly; but the same agent indirectly causes the same flowers to close up again, after the disappearance of the swelling through evaporation. This, he contends, accounts for the early closing of flowers under a high temperature, or in dry soils. We have always understood that this phenomenon was governed by the hygrometrical conditions of the atmosphere.

The *Revue des Eaux et des Forêts*, 1875, gives some statistics of the constituents of the forests of Denmark. The beech is now the most universal, having gradually succeeded in displacing the oak and pine. Next in order are the birch, alder, aspen, hazel, &c. Although at a very remote period pines appear to have formed the principal forests of Denmark, they are not now indigenous, nor have they been for many centuries; indeed, they do not thrive when introduced. According to the celebrated Danish geologist, M. Forchhausmer, the beech grows best in the formation which he calls *argile caillouteuse*, or *argiles à blocs erratiques;* whereas the oak prefers the *sable caillouteuse*, or *sable à blocs erratiques.* An examination of the vegetable remains in the bogs so common in Denmark reveals the fact that the earliest forests were composed of pines, followed by the sessile-fruited variety of the oak, now to a great extent superseded by the beech, &c. It is supposed that the pine forests flourished during the *âge de la pierre à éclats;* and the oak was at its greatest development at the commencement of the bronze age.

Amongst the several ameliorations which are in preparation at the Ministry of Public Instruction in France, is the remodelling of the *baccalaureat* in a manner which is likely to benefit the study of medicine and the spread of the study of science. The *baccalaureat* of sciences is to be required as formerly from students in medicine; but after having passed a general examination for their first *baccalaureat* they will be examined in a second *baccalaureat* of *sciences physiques*, which includes not only physics, but general notions of botany, zoology, mineralogy, &c. The general *baccalaureat* is common to students in medicine and in mathematics, the students of the latter branch having to pass a special examination of their own entitled *Baccalaureat des Sciences Mathematiques.*

We believe that the Belgian Government is about to establish tide gauges on the Escault, and to undertake complete researches on the tides and currents of the coasts of Belgium generally. Prof. Van Rysselberghe, the inventor of the self-recording meteorograph, to which we have already called attention, has been attached to the Hydrographic Department, with a view of aiding in these researches.

We would direct the attention of our biological readers to a translation from the *Berliner Klinische Wochenschrift*, in the current number of the now monthly *London Medical Record*, of a paper by Dr. Scheele, of Dantzig, on two cases of complete transposition of the viscera, together with valuable observations and references on the subject generally.

An interesting ceremony recently took place at Estagel, a small country town in the Department of the Pyrenees, where the great Arago was born. The local authorities and an immense number of people have celebrated the tenth anniversary of the erection of a statue of that astronomer. No scientific speaker was present, and Arago was merely eulogised in general terms for his science as well as for his patriotism.

The vanilla plant has lately been attacked by a disease which has greatly interfered with its cultivation. Chemistry has been brought to bear in the production of a new substance from which the "vanilla essence" is produced. Messrs. Hartig and Kubel, two German chemists, have found in the *cambium* of conifers a species of resin which, after certain processes, produces an aroma exactly similar to that of the vanilla, and which possesses the same composition as that of the true vanilla essence itself. This *pseudo* vanilla is sold largely in Germany for the real article; its price is about two-thirds that of the true vanilla essence.

On Tuesday last there was a private view of the works of the Westminster Aquarium and Winter Garden. From their unfinished state it was not possible to form an accurate idea of the contemplated arrangements, but the considerable area already occupied or to be covered with buildings struck everybody. At the luncheon subsequently given the Managing Director made a speech, in which much was said about science and intellectual enjoyment. Undoubtedly the Company will have a powerful engine at its disposal either for instruction or amusement.

No. 3, vol. iv., of the Proceedings of the Geological Association, contains, besides pleasant descriptions of some excursions, the following papers:—"On the deposits now forming in British seas," by G. A. Lebour; "Notes on specimens of Phosphorate from the Department of the Lot, France," by F. W. Rudler; "A probable origin of the perforation in sharks' teeth, from the Crag," by H. A. Burrows; and "On the conditions of animal life in the Deep Sea bottom," by Dr. W. B. Carpenter.

The additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus radiatus*) from India, presented by Mr. Turnbull; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Knight; two Common Wolves (*Canis lupus*) from Russia, presented by Mr. Charles Bell; a Chinese Mynah (*Acridotheres cristatellus*) from China, presented by Mr. J. R. France; two Rattlesnakes (*Crotalus durissus*) from N. America, a Long-nosed Crocodile (*Crocodilus cataphractes*) from W. Africa, received in exchange; five Russell's Vipers (*Vipera russelli*) born in the Gardens.

SOME LECTURE NOTES UPON METEORITES

NOWHERE in the "Cosmos" does Alexander von Humboldt show more vividly his keen appreciation of all the grander operations of nature than in those passages in which he discusses the subject of meteors, and in which he gives us a forecast of the connection of those striking and still not entirely explained phenomena with other celestial spectacles, such as the apparition of comets and the fall of meteorites.

Thus Humboldt dwells with a lingering interest on the subject of the meteoric showers which in their grandest form, on at least one, and generally on some successive Novembers in every generation, and in a less brilliant degree on every 10th of August, illuminate the sky with countless lines of momentary light. And while bringing the occurrence of these swarms of meteors with much vividness before our eyes, he treats them as a special form of the same display presented by the single meteor, that, gliding down the sky, leaves its thread of light to illuminate a few degrees of the great arc described on the dome of heaven by the meteor; nor does he hesitate to link these phenomena into one series with those larger meteoroids that we call fireballs, and which sometimes light up the whole heavens, and may occasionally be seen over half a continent. And we may go on with Humboldt to connect with these greater meteors a class of still more striking phenomena accompanying the descent generally out of a dark cloud when seen in daylight, or with a bright flame, when seen by night, of meteoric stones, heralded by sounds as of thunder.

Within the last few years the cases of recurring periods of meteoric showers have been considerably multiplied, while these and the comets have been recognised by astronomers as belonging to the same order of celestial objects: and we are now enabled to group the whole of the phenomena we are considering under a single category with a confidence far greater than that on which Humboldt built his surmise regarding them.

It is with the meteoric bodies that fall from out of a cloud when seen by day, and in fiery mass where the light can be distinguished, and accompanied by detonations like cannon, that we are going more immediately to deal here; and it may be well therefore, without recalling the descriptions that may be found in many treatises of some of the more familiar meteoric falls, such as those of L'Aigle and of Braunau, to recount the evidence of eye-witnesses of these events on other occasions. The following is a contemporary account of the fall of a shower of stones in the county of Limerick, at Adare, on Sept. 10, 1813:—

"Friday morning, the 10th September, 1813, being very calm and serene, and the sky clear, about 9 o'clock, a cloud appeared in the east, and very soon after I heard eleven distinct reports, appearing to proceed thence, somewhat resembling the discharge of heavy artillery. Immediately after this followed a considerable noise not unlike the beating of a large drum, which was succeeded by an uproar resembling the continued discharge of musketry in line. The sky above the place whence this noise appeared to issue became darkened and very much disturbed, making a hissing noise, and from thence appeared to issue with great violence different masses of matter, which directed their course with great velocity in a horizontal direction towards the west. One of these was observed to descend; it fell to the earth, and sank into it more than a foot and a half, on the lands of Scagh, in the neighbourhood of Patrick's Well, in the county of Limerick. It was immediately dug up, and I have been informed by those that were present, and on whom I could rely, that it was then warm, and had a sulphurous smell. It weighed about 17 lbs., and had no appearance of having been fractured in any part, for the whole of its surface was uniformly smooth and black, as if affected by sulphur or gunpowder. Six or seven more of the same kind of masses, but smaller, and fractured, as if shattered from each other or from larger ones, descended at the same time with great velocity in different places between the lands of Scagh and the village of Adare. One more very large mass passed with great rapidity and considerable noise at a small distance from me; it came to the ground on the lands of Brasky, and penetrated a very hard and dry earth about two feet. This was not taken up for two days; it appeared to be fractured in many places, and weighed about 65 lbs.! Its shape was rather round, but irregular. It cannot be ascertained whether the small fragments which came down at the same time corresponded with the fractures of this large stone in shape or number, but the unfractured part of the surface has the same appearance as the one first mentioned. There fell also at the same time, on the lands of Faha, another stone, which does not appear to have been part of or separated from any other mass; its skin is smooth and blackish, of the same appearance with the first-mentioned; it weighed above 74 lbs.; its shape was very irregular. This stone is in my possession, and, for its volume, is very heavy.

"There was no flash of lightning at the time of, or immediately before, or after the explosion; the day continued very calm and serene, was rather close and sultry, and without wind or rain. It is about three miles in a direct line from the lands of Brasky, where the very large stone descended, to the place where the small ones fell in Adare, and all the others fell intermediately; but they appeared to descend horizontally, and as if discharged from a bomb and scattered in the air."

The next account is that of a stone that fell at Durala, or Dooralla, on February 18, 1815.

Extracts from a Letter from Capt. G. Bird.

"Loodiana, April 5, 1815.

"On the 18th February last, some people who were at work in a field about half a mile distant from the village of Dooralla were suddenly alarmed by the explosion of what they conceived to be a large cannon, 'the report being louder than that of any other gun they had ever heard,' which report was succeeded by a rushing noise like that of a cannon ball in its greatest force. When looking towards the quarter whence the noise proceeded, they perceived a large black body in the air, apparently moving directly towards them, but, passing with inconceivable velocity, buried itself in the earth at the distance of about 60 paces from the spot where they stood. The Brahmins of the village, hearing of it, proceeded to the spot with tools for digging it up. They found the surface broken, and the fresh earth and sand thrown about to a considerable distance, and at the depth of rather more than 5 ft. in a soil of mingled sand and loam they found the stone, which they cannot doubt was what actually fell, being altogether unlike anything known in that part of the country. The Brahmins conveyed it to the village, covered it with wreaths of flowers, and started a subscription for the purpose of raising a small temple over it. It fell on the 18th of February, about mid-day, in a field near the village of Dooralla, which lies about lat. 30° 20′, long. 76° 41′, within the territory belonging to the Pattialah Rajah, 16 or 17 miles from Umballa, and 80 from Loodiana. The day was very clear and serene, and, as usual at that season of the year, not a cloud was to be seen, nor was there in the temperature of the air anything to engage their attention; the thermometer of course may be stated about 68° in the shade. The report was heard in all the circumjacent towns and villages, to the distance of 20 coss, or 25 miles, from Dooralla. The Rajah having been led to consider it as a messenger of ill omen, according to my wish gave immediate orders for its conveyance to Loodiana, but with positive injunctions that it should not approach his place of residence. It weighs rather more than 25 lbs., and is covered with a pellicle thinner than a wafer, of a black sulphureous crust, though it emits no smell of sulphur that I can discover. It is an ill-shapen triangle, and from one of the corners a piece has been broken off, either in its fall or by the instruments when taken out of the ground. This fracture discloses a view of the interior, in which iron pyrites and nickel are distinctly visible. No Hindoo ventures to approach it but with closed hands in apparent devotion, so awful a matter is it in their eyes."

This aërolite was brought from India by Lieut.-Col. Pennington, and presented to the Hon. East India Company. It is now in the British Museum.

The next description is that of the fall of a stone at Manegaum, in Kandeish, on June 29, 1843. The account is given by two Hindoo eye-witnesses:—

"On the day the aërolite fell we were both seated, about 3 o'clock in the afternoon, on the outskirts of the village, in a shed belonging to Ranoo Patel. There was at the time no rain, but heavy clouds towards the northward. There had been several claps of thunder for two hours previously, and some lightning. Suddenly, while we were seated in the shed, several very heavy claps of thunder occurred in quick succession, accompanied with lightning, on which we both went out to look around us, when, in the middle of a heavy clap, we saw a stone fall to the ground in a slanting direction from north to south, preceded by a flash of lightning. It fell about 50 paces from us. On going up to it we found that it had indented itself some four or five inches into the ground; it was broken in pieces, and, as far as we could judge, appeared to be about fifteen inches long, and three inches in diameter, of an oblong shape, somewhat similar to a Chouthe grain measure; it was of a black vitreous colour outside, and of a greyish yellow inside; it was then of a mouldy texture, and hardened to the consistence of the present specimens afterwards.

"Only one stone fell. No rain had fallen for eight days previously, nor did it for four days after the fall of the stone. It had been warm all day before, but not much more so than usual. From mid-day till the time the stone fell (3 P.M.) it was very cloudy towards the northward; after its fall the thunder ceased, and the clouds cleared away. No stone of a similar description had ever fallen near our village before. The pieces of the stone were immediately after carried off by the country people. Our village is situated on the banks of the small river, the Poorma. There are no hills in its vicinity, the nearest being 3 coss (or 6 miles) off."

Finally, we may extract from the contemporary notices published in the United States, the more remarkable circumstances attending the fall of a great number of aërolites at New Concord, U.S.A.:—

"About fifteen minutes before one o'clock, May 1, 1860, the people of South-eastern Ohio and North-eastern Virginia were startled by a loud noise. . . . . The area over which the explosion was heard was probably not less than 150 miles in diameter. . . . . An examination of all the different directions leads to the conclusion that the central point from which the sound emanated was near the southern part of Noble County, Ohio. . . . .

"Twenty-three distinct detonations were heard, after which the sounds became blended together, and were compared to the rattling fire of an awkward squad of soldiers, and by others to the roar of a railway train. These sounds, with their reverberations, are thought to have continued for two minutes. The last sounds seemed to come from a point in the south-east, 45° below zenith. The result of this cannonading was the falling of a large number of stony meteorites upon an area of about ten miles long by three wide. The sky was cloudy, but some of the stones were seen first as 'black specs,' then as 'black birds,' and finally falling to the ground. A few were picked up within twenty or thirty minutes. The warmest was no warmer than if it had lain on the ground exposed to the sun's rays. They penetrated the earth from 2 ft. to 3 ft. The largest stone, which weighed 103 lbs., struck the earth at the foot of a large oak tree, and after cutting off two roots, one 5 in. in diameter, and grazing a third root, it descended 2 ft. 10 in. into hard clay. This stone was found resting under a root which was not cut off. This would seemingly imply that it entered the earth obliquely. It is said that other stones which fell in soft ground entered the earth at a similar angle. They must have been flying in a north-west direction. This fact, added to the other facts, that the detonations heard at New Concord came lower and lower from the zenith toward the south-east, and that the area upon which the stones fell extends with its longer axis in a south-east and north-west direction, would imply that the orbit of the meteor, of which these stones are fragments, extended from south-east to north-west. This conclusion is confirmed by the many witnesses who saw at the time a luminous body moving in the same direction. It is a fact of some interest that the larger stones were carried by the orbital force further than the small ones, and were found scattered upon the north-west end of the area referred to.

. . . .

"Prof. Evans computes, from data supplied by several reliable witnesses, the altitude of the meteor when first seen to range between thirty-seven and forty-four miles.

. . . .

"A train accompanying the stones is described as a cone, having its base upon a fire-ball. As seen from near Parkersburg its length was estimated at twelve times the diameter of the ball. The part next the base appeared as a white flame, but not so bright as to render the outline of the ball indistinct. About half way toward the apex it faded into a steel blue.

. . . .

"Near McConnellsville several boys observed a huge stone descend to the earth which they averred looked like a red ball, leaving a line of smoke in its wake." McConnellsville is twenty-five miles south of Concord.

. . . .

Another observer at Berlin saw a ball of fire flying in a northerly direction with great velocity. It appeared as white as melted iron, and left a bright streak of fire behind it which soon faded into a white vapour. This remained more than a minute, when it became crooked and disappeared. Berlin is about 80 miles south-west of Concord.

Now, these and other descriptions of similar events witnessed by people in different parts of the world substantially agree. In some minute circumstances they naturally differ, as doubtless do also the events themselves or the conditions under which they are witnessed. The appearance of a cloud at a great elevation, its rapid motion, the emanation from it of masses of matter ultimately falling to the earth, the association with these appearances of a fiery light forming a splendid spectacle that lights up the heavens by night and in twilight, and is often also seen by day; the trail that follows the great meteoroid mass, and lingers on the air in the form of a long-drawn film of cloud that remains luminous by night for some short period after the passage of the luminous ball or cone,—are phenomena to which witness is borne in many cases besides the last above recorded. Testimony is also concurrent on the loudness and repetition of detonations that accompany these phenomena, irrespectively of their multiplication by the effect of echo. In the case of a group of meteorites that fell at Butsura, in India (near Goruckpore), on May 12, 1861, we have evidence of three different explosions.

Now, for some parts of the phenomena thus recorded we can offer satisfactory explanations, though of other parts of them the explanations hitherto offered may seem not quite so complete.

First, we have the enormous velocity with which such a body comes into our atmosphere, sufficient in some cases to bear the meteorite through the distance from London to Edinburgh in as many seconds as an express train takes hours; and where the body enters our atmosphere that medium is so rare that we can hardly conceive it presenting any resistance; yet even at that enormous elevation—certainly in many cases as much as forty miles above the earth, where the meteor enters this fine atmosphere—there cannot be a doubt that the atmospheric resistance at once called into play is sufficient to impede the body that enters it with so enormous a velocity. And by virtue of a principle which is now an axiom of science, this arresting of the velocity of the meteorite means calling into activity intense heat that is largely imparted to the meteorite itself—heat, in fact, that is proportional to the velocity for which it is exchanged.

Now, these meteoric masses must often come into our atmosphere, not individually, but in swarms. From the rapidity with which the heat is developed, and partly also as a consequence of the low conductivity for heat of the stony masses, their surface only has time to experience the effects in the few seconds of transit, and therefore only the surface fuses; and, as a consequence of this fusion, there arises a sort of spray of meteoric dust flung off from the meteorite or from the meteoric swarm; and this forms a cloud, such as may be seen lingering on the track of almost any large meteor that is visible by daylight. To the material nature of such a cloud as it rests, or rather, though rapidly falling, seems to rest, poised in the air, the writer can bear personal testimony, having witnessed it in the train of a fine meteor many years ago, about sunset. When the ordinary clouds had long ceased to be tinted by the rays of the evening sun, as in the after-glow on the Alps, the long line of meteoric cloud became lit up with rose-tinted hues, and bending into a curve towards the east before an upper current of air, offered proof beyond question of the material nature of this cloud, and at the same time of its great elevation and the fine state of division of its dust-like particles, which undoubtedly resulted from the disintegration of the meteoric mass in its passage through the air. The same cloud of dust is often visible as a luminous trail by night, in consequence partly of its retaining its incandescence for a certain time, but probably also in part from the phosphorescence of its material. We are thus able to offer an undoubtedly true explanation of one part of the spectacle.

The existence in the crust of a meteorite of projecting particles of unoxidised meteoric iron, and, in the case of the Busti meteorite, of calcium sulphide unaltered, is explained by the momentary character of the process which during the flight of the meteorite perpetually removes the outer surface and exposes a fresh one, which, however, is always screened by a protecting glaze of fused silicate from the immediate action of the air, so long as there is velocity enough left to the mass thus to fuse and to throw off in its wake fresh portions of its surface; while in the later stage of its flight the glaze accumulates into a denser crust highly charged with magnetic iron oxide, mainly the result of the oxidation of the iron of the silicates.

The cause or causes of the explosions are more difficult to demonstrate. They have been accounted for in two separate ways, which, though different, are not inconsistent, and are both probably involved in a complete explanation of the disruption and detonations. Why should a meteorite explode with a repor which could be heard forty or fifty miles away? Nay, why should it explode at all?

One answer is this. The aërolite comes into our atmosphere from regions in which the temperature, "the cold of space," may range as low as 140° below zero Centigrade; and though the mass, from the absorption of solar heat, would possess a temperature much above this, it would nevertheless be intensely cold, and consequently more brittle than at ordinary temperatures; and hence, on its entering our atmosphere, the heat it instantaneously acquires on its outer portion expands this, and tends to tear it away, so as to dissever the exterior from the interior, which continues to be relatively contracted by the intensity of the cold which the aërolite brings with it from space. The consequence is, first, that little bits of the stone spring out all over it, leaving those curious little holes or pit marks which are characteristic of a meteorite; and every now and then, as the heat penetrates, larger masses split away, of which interesting evidence is afforded by the meteorite, for instance, that fell at Butsura on May 12, 1861. Fragments of this stone were picked up three or four miles apart; and by supplementing them by a small piece modelled to fill up one lacuna, one is able to build up again with much certainty the original meteorite, or at least the portion of it represented by the fragments of it which were found. Important portions of this stone are in the British Museum, presented some years ago by the liberality of that invaluable institution, the Asiatic Society of Calcutta. Now, it is remarkable that these fragments, which in other respects fit perfectly together, are, even on the faces of junction, now coated with a black crust. On the other hand, another of these fragments not thus coated fits like the former to a part of the meteorite that was found some miles away from it, and is also not incrusted at the surface of fracture. Hence we can assert that this aërolite acquired after coming into our atmosphere a scoriated and blackened surface or incrustation. The first explosion drove the fragments first alluded to asunder, and these became at once incrusted on their broken surfaces; but others that were separated afterwards, probably on the last of the three explosions, had not sufficient velocity left to cause their incrustation in the same manner as was the case with the fragments previously severed. Now, this successive incrustation of the fragments of the meteorite confirms the idea that the disruption of the mass, and the explosions heard for so vast a distance as Goruckpore (some sixty miles), are parts of the same convulsion; and sixty miles is by no means an uncommon distance for the sound of such a meteoric explosion to be heard.

The late W. von Haidinger (to whom we are indebted for a collation of the facts and for valuable suggestions bearing on this subject) threw out the notion that what really produced the detonation was not the disruption of the mass (which he held not to be a sufficient cause for so loud a report) so much as the collapse of the air into a vacuum which, after following the meteorite as it pursued its rapid course, suddenly ceased to exist as the velocity of the meteorite became practically reduced to zero.

But it still would remain to be explained why at one time more than another this collapse of the vacuum should take place, or how it could be repeated; of this, however, a sufficient explanation would seem to be afforded by the actual bursting asunder of the meteorite from the cause before assigned, since this explosion, by disturbing the conditions on which the persistence of the vacuum depends, would permit the collapse of the air and consequent detonation.

(*To be continued.*)

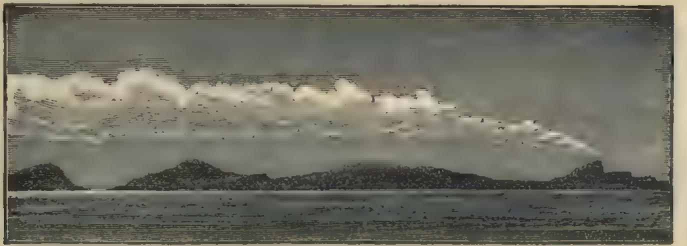
*OBSERVATIONS ON A REMARKABLE FORMATION OF CLOUD AT THE ISLE OF SKYE**

THE resistance offered by the earth's surface to the wind is known to reduce its velocity and to cause deviations in its direction both horizontal and vertical, as well as to retard the progress of the storm itself. This friction to which aërial currents are subjected is probably least for a surface of water such as the sea—greater for plains of loose sand, where, as in the Nubian deserts, lofty sand pillars are produced—and greater still where the surface is immoveable, as in the case of solid land; but the greatest resistance of all is due to the obstruction offered by rugged hills and lofty mountain-ranges.

In an account of the Morayshire easterly storm of September 1871; published in the *Scottish Meteorological Journal*, I suggested that the great amount of rainfall which fell on that occasion at and near the Morayshire coast, and on the sea-coasts of the counties of Fife and East Lothian which also fronted this storm, was due to the sudden increase of friction which the wind encountered when it reached the land. The in-shore stream of air being checked by the unyielding nature of the shore, even though it was, as in this case, of no great elevation, would form a pillow of obstructed or perhaps nearly stationary air, which would produce vertical deflection on the strong currents coming in from the sea. The stream of air thus projected upwards to a height where the temperature is lower would be condensed into vapour and rain.

This sudden change of resistance to in-shore winds is probably one of the causes of the well-known peculiarity of seaside climates.

On the 27th July last, about 11.30 A.M., when in the steamer of the Northern Lighthouses off the Sound of Harris, I saw a beautiful example of the genesis of clouds—due, however, not to a low foreshore, but to hills of about 900 feet high. The sky was perfectly clear, with a steady but very slight breeze from the S.W., which came straight upon the south-western extremity of the Island of Skye, distant about twelve miles from the ship. A small portion of the most southerly projection of the island, which was considerably lower than the more inland parts, was perfectly free from vapour, but at a short distance inland from the shore, there was an abrupt face of hill, from the top of which there rose a very slender column of white vapour which gradually expanded as it ascended into the air, presenting exactly the appearance of the escape of steam from the spiracle of a volcano. The cloud thus formed not only extended as far as the northern extremity of Skye—itself a distance of twenty-eight miles—but was visible as a well-defined stratum of cloud for a long distance beyond Skye, so that its whole length must have considerably exceeded forty miles, beyond which distance it became more diffuse and attenuated. Had I not known to the contrary, I should undoubtedly have believed that what I saw was due to volcanic eruption.



The vapour caused by the lower temperature of the atmosphere at the level of the top of the bluff face was obviously carried away by the breeze gradually as it was formed, thus producing by a continuous process of generation the long extent of cloud which I have described. This fact shows that clouds may be due to deflections produced by irregularities on the earth's surface far remote from the place where we actually see them. I may mention, in proof of the steady nature of the breeze and of the entire absence of any vertical disturbance in the atmosphere, that later in the day we traced the smoke from the steamer's funnel for a distance of nearly fifteen miles.

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* By Thomas Stevenson, F.R.S.E.

The accompanying woodcut is from a sketch which I made on board the vessel at the time, and I doubt not will be interesting to your readers.

SCIENTIFIC SERIALS

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, August 15.—This number contains a description, with diagrams, of Theorell's printing meteorograph, a very ingenious instrument, likely to be of much service in meteorology. It differs from other meteorographs in this, that instead of tracing curves, which have to be afterwards translated into figures, it prints the figures at once, thus saving much future trouble. One of the three already made has been in use at the Royal Observatory of Vienna since September 1874, and has been so adapted as to record, by electric communication, the state of the following instruments, placed in any situation: anemometer, vane, wet and dry thermometers, and barometer, once in every quarter of an hour. The moving force is a galvanic current connected with a clock. Dr. Theorell's account of the instrument referring to the plates will be continued in the next number of the *Zeitschrift*. In the "Kleinere Mittheilungen" Prof. Hoffmann, of Giessen, compares the sum of the daily maxima of solar radiation in several years with the time of the flowering of certain plants. His results in 1875 bear out his expectations derived from four previous years' observations, 1866-69, and in certain cases his forecast of the time of flowering was nearly correct.—There is besides a paper by Dr. Schreiber on a new registering air thermometer; also a letter from Mr. Ferrel on the theory of storms.

Jahrbuch der Kais.-kön. Geologischen Reichs-Anstalt, Band 24, heft iv.—Nearly all this part of the *Jahrbuch* is occupied by the second part of Dr. Guido Stache's elaborate memoir on the Palæozoic regions of the eastern Alps. In this part he summarises all that is known respecting the geology of the western slopes (Cadoric Alps) of the area embraced in his review.—The only other paper is one by M. V. Lipold—"Explanation of the geological map of the environs of Idria, in Carniola." A coloured map and plate of horizontal sections accompany the paper.—In Dr. Tschermak's "Mineralogische Mittheilungen" Dr. R. v. Drasche concludes his paper, entitled "Petrographic-geological Observations on the West Coast of Spitzbergen." The editor describes the *Labradorite* of Verespatak; and a notice of two other minerals, *Famatinite* and *Wapplerite*, is given by A. Frenzel.

THE *Boletin de la Academia Nacional de Ciencias exactas en la Universitad de Cordova* (*South America*), Entrega iii., 1874, contains some papers of interest. We note the following:—On the chemical composition of the water of the La Plata River, by Señor Kyle.—On the formation of saline deposits, by D. Fred. Schickendantz.—On the chemical and physical action which took place in the formation of the pampas of Cordova, by Dr. A. Doering.—Critical notices on some entomological publications, by Dr. D. C. Berg.

THE *Annali di Chimica applicata alla Medecina* (August) contain the following papers of note:—On salicylic acid, by Dr. D. Gibertini.—Note on chloral-santonine, by C. Pavesi.—On the health of smokers, by Dr. Bertherand.—On the substitution of iron shot for lead shot for the purpose of cleaning bottles in hospitals, barracks, &c., by Sig. Fordos.—On the comparison of human milk with cows' milk with regard to the nutrition of infants, by Ph. Biedert.—A number of papers of minor interest.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, July 15.—On the solubility of calcic chloride in water, by H. Hammerle.—On the decrease in the temperature of the maximum of density of water through pressure, by C. Puschl.—On the system of vessels of the tube-bones, with notes on the structure and development of bones, by C. Langer.—Researches on the capacity of gas-mixtures for conducting heat, by J. Plank.—On the theory of the composite eyes and the seeing of motions, by Dr. S. Exner.—On the graduation of induction apparatus, by Dr. E. Fleischl.—Researches on the motion of the imbibition-water in wood and in the membrane of the vegetable cell, by Prof. Wiesner.—On the morphology and biology of Lenticellæ, by G. Haberlandt.—Meteorological observations made at Hohe Warte, near Vienna.

July 22.—(Last meeting before holidays).—Remarks on the variations in the velocity of light passing through quartz which is subjected to pressure, by J. Merten.—The Crustacea, Pygnogonida, and Tunicata of the Austro-Hungarian North Polar Expedition, by C. Heller.—On the finer structure of bone substance, by Prof. von Ebner.—On the construction of the reflection goniometer, by Prof. von Lang.—(The next meeting will take place on Oct. 14.)

K.K. Geologische Reichsanstalt, May 31.—Report from Dr. O. Lenz on his travels in Africa.—On the occurrence of marine petrefacts in the Ostrau layers, by D. Stur.—On the coal deposits of Drenovec, by Dr. R. Hörnes.

June 30.—On the Island of Kos, by Dr. M. Neumayer.—On fresh-water strata amongst the Sarmatic deposits near the Sea of Marmora, by Dr. R. Hörnes.—On the landslip near Unterstein, on the Salzburg-Tyrol Railway, by H. Wolf.

July 31.—On some fossil plants from India, by O. Feistmantel. On the formation of the terra rossa, by Th. Fuchs.—On mountain folds, by the same.—On secondary infiltrations of carbonate of lime into loose and porous formations, by the same.—Report by D. Stur on his travels in Silesia.—On the fauna of the Schliers of Ottnang, in Upper Austria, by R. Hörnes.

STOCKHOLM

Kongl. Vetenskaps Akademiens Förhandlingar, March 10.—The following papers were read:—Genera et species Lithobioidarium disposuit, by A. Stuxberg.—Review of all Lithobioidæ hitherto known in North America, by the same.—Report on the bryological researches in Norway during 1874, by C. Hartman.—On the moss flora of Lulea (Lappmark), by P. J. Hellbom.—On the observation of two crossing rainbows, by O. Gumaelius, with some remarks on the same, by R. Rubenson.

April 14.—On the marine Entomostraca collected during the Swedish Scientific Exhibition to Spitzbergen, by W. Lilljeborg.—On the formation of the smaller bays, of the river valleys, of lakes, and of sea banks, by A. Helland.

GÖTTINGEN

Nachrichten von der königl. Gesellschaft der Wissenschaften, Aug. 7.—The following papers were read:—On lens fibres, by Prof. J. Henle.—On the linear differential equations of the second order which possess algebraic integrals, and on a new application of the "invariant" theory, by Prof. L. Fuchs.

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ERRATA.—Vol. xii. p. 455, col. 1, line 8 from bottom, for "time t" read "very small time t." P. 463, col. 1, line 21 from bottom, for "$2_n + _2$" read '$2n + 2$.'

THURSDAY, OCTOBER 7, 1875

THE ASTRONOMY OF THE BABYLONIANS

THE astronomical science of the ancient Babylonians and their pupils, the Assyrians, was neither so profound nor so contemptible as has often been maintained. Now that we are able to read the native records written in the cuneiform or wedge-shaped character, we find that the progress made at a very early period in mapping out the sky, in compiling a calendar, and above all in observing the phenomena of the heavens, was really wonderful, considering the scanty means they possessed of effecting it. Certainly their astronomy was mixed up with all kinds of astrological absurdities, but this did not prevent them from being persistent and keen observers, whose energy in the cause of knowledge is not undeserving of imitation even in the present day.

The originators of astronomy in Chaldea, as indeed of all other science, art, and culture there, were not the Semitic Babylonians, but a people who are now generally termed Accadians, and who spoke an agglutinative language. They had come from the mountains of Elam or Susiana, on the east, bringing with them the rudiments of writing and civilisation. They found a cognate race already settled in Chaldea, and in conjunction with the latter they built the great cities of Babylonia, whose ruins still attest their power and antiquity. Somewhere between 3000 and 4000 B.C. the Semites entered the country from the east, and gradually contrived to conquer the whole of it. It is probable the conquest was completed about 2000 B.C. At all events, Accadian became a dead language two or three centuries later, but as the Semitic invaders owed almost all the civilisation they possessed to their more polished predecessors, it remained the language of literature, like Latin in the Middle Ages, down to the last days of the Assyrian Empire.

Astronomy was included in the branches of science borrowed by the Semitic Babylonians from the Accadians. Consequently their astronomical records contain many words which belong to the old language, while most of the stars bear Accadian and not Semitic names. Even where the Assyro-Babylonians had a technical term of their own, like *kasritu*, "conjunction," they continued to *write* the old Accadian word *ribanna*, of which *kasritu* was a translation, though they probably *pronounced* it *kasritu*, just as we pronounce *viz.* "namely."

The oldest Chaldean astronomical records of which we know are contained in a great work called "The Observations of Bel," in 70 books, compiled for a certain King Sargon of Agané, in Babylonia, before 1700 B.C., and of which we possess later copies or editions, made for the Library of Sardanapalus at Nineveh. The catalogue of this work shows that a great part of it was purely astrological; other books, however, were more scientific. Thus there was one on the conjunction of the sun and moon, another on comets, or, as they are called, "stars with a corona in front and a tail behind," a third on the movements of Mars, a fourth on the movements of Venus, and a fifth on the Pole-star.[*] The catalogue concludes with a curious intimation to the student, who is told to write down the number of the tablet or book he wishes to consult, and the librarian will thereupon hand it to him. The larger portion of the work itself has been recovered, though some of the tablets belonging to it still lie under the soil of Kouyunjik, and a good part of the details which follow is extracted from this primitive Babylonian treatise.

The Accadians seem to have begun their astronomical observations before they left Elam, since the meridian was placed in that country, while the old mythology made "the mountain of the East" the pivot on which the sky rested. This will account for the large number of eclipses recorded in the "Observations of Bel," which imply a corresponding antiquity for the commencement of such records. These records were carefully kept, as there were State Observatories in most of the Babylonian and Assyrian towns—at Ur, Agané, Nineveh, and Arbela, for instance—and (at all events in later times) the astronomers royal had to send fortnightly reports to the King.

It is to the Accadians that we owe both the signs of the Zodiac and the days of the week. The heaven was divided into four parts, and the passage of the sun through these marked the four seasons of the year. A tablet brought home by Mr. Smith informs us that the spring quarter lasted from the 1st of the month Adar to the 30th of the month Iyyar (that is, from the 1st degree of Pisces to the 30th degree of Taurus), the summer quarter from the 1st of Sivan to the 30th of Ab (the 1st degree of Gemini to the 30th of Leo), the autumn quarter from the 1st of Ebul to the 30th of Marchesvan (the 1st degree of Virgo to the 30th of Scorpio), and the winter quarter from the 1st of Chisleu to the 30th of Sebat (the 1st degree of Sagittarius to the 30th of Aquarius). The fact that the spring quarter did not commence with the beginning of the year in Nisan or March, shows that the scheme was subsequent to the formation of the calendar.

The year was divided into twelve lunar months and 360 days, an intercalary month being added whenever a certain star, called "the star of stars," or *Icu*,[*] which was just in advance of the sun when it crossed the vernal equinox, was not parallel with the moon until the 3rd of Nisan, that is, two days after the equinox. This, however, did not always suffice to keep the seasons in order, and the calendar had more than once to be rectified by the intercalation of other so-called months, consisting of a few days each. Cycles of twelve solar years were also in use, during which the same weather was expected to recur. The day was divided into twelve *casbumi*, or "double hours," each of these being further subdivided into sixty minutes and sixty seconds. The month, too, was cut into two halves of fifteen days, each subdivided into periods of five days, though a week of seven days was also employed from the earliest times. The days of the week were named after the sun, moon, and five planets; and since the 7th, 14th, 19th, 21st, and 28th of the month were termed "days of rest" on which certain works were forbidden to be done, it is clear that the origin of our modern week must be referred to the ancient Chaldeans. The names of the months were taken from the corresponding signs of the Zodiac, and as the Zodiac began with Aries and the year with Nisan, neither the Zodiac nor the Calendar of the Accadians could be earlier than 2540 B.C. This is also indicated by the fact that even as late as the composition of the "Observations of Bel," time is calculated in the case of eclipses, not by the *casbu*, or "double hour"—a word which is Accadian, and not Semitic—but by the older division into three watches. These consisted of four hours each, beginning at 6 P.M. and ending at 6 A.M., and they were called respectively the "evening," "middle," and "morning" watches. Something like an accurate measurement of time was attained by the invention of the clepsydra.

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[*] That is, α Draconis.

[*] Called *Dil-gan*, or "messenger of light," in Accadian. It must be identified with τ Arietis, and at a later time with α Arietis.

Eclipses of the moon were observed from a very early epoch; but numerous as are the records of them in the great astronomical work of Sargon's Library, the vague and unscientific way in which they are recorded renders them of little value. The usual formula is: "In the month so and so, on the 14th day, an eclipse takes place, beginning on the east and ending on the west: it begins in the middle watch [10 P.M. to 2 A.M.], and ends in the morning watch, the shadow being eastward from the commencement to the cessation of the eclipse." In subsequent times, however, the language of the observatory reports becomes more precise and the gradual progress of an eclipse is carefully described. Long before the reign of Sargon of Agané, the discovery had been made that lunar eclipses recur after a cycle of 223 lunations, and records of them incorporated into the "Observations of Bel" generally begin with the words "According to calculation," or (it may be) "Contrary to calculation, the moon was eclipsed." One of the most curious tablets now in the British Museum is one of lunar longitudes, which seems to have formed part of the great Babylonian work on Astronomy, but, since it is written in Accadian, must be older than 2000 B.C. As a translation of it has not been made before, it is here given in full:—

1.	The 1st day	(the moon)	advances	... ...	5 deg.
2.	The 2nd day	,,	,,	... ...	10 deg.
3.	The 3rd day	,,	,,	... ...	20 deg.
4.	The 4th day	,,	,,	... ...	40 deg.
5.	The 5th day	,,	,,	... ...	80 deg.
6.	The 6th day	,,	,,	... ...	96 deg.
7.	The 7th day	,,	,,	... ...	112 deg.
8.	The 8th day	,,	,,	... ...	128 deg.
9.	The 9th day	,,	,,	... ...	144 deg.
10.	The 10th day	,,	,,	... ...	160 deg.
11.	The 11th day	,,	,,	... ...	176 deg.
12.	The 12th day	,,	,,	... ...	192 deg.
13.	The 13th day	,,	,,	... ...	208 deg.
14.	The 14th day	,,	,,	... ...	224 deg.
15.	The 15th day	,,	,,	... ...	240 deg.
16.	The 16th day for 224 deg. of advance it retrogrades*				16 deg.
17.	The 17th day for 208 deg.	,,	,,		32 deg.
18.	The 18th day for 192 deg.	,,	,,		48 deg.
19.	The 19th day for 176 deg.	,,	,,		64 deg.
20.	The 20th day for 160 deg.	,,	,,		80 deg.
21.	The 21st day for 144 deg.	,,	,,		96 deg.
22.	The 22nd day for 128 deg.	,,	,,		112 deg.
23.	The 23rd day for 112 deg.	,,	,,		128 deg.
24.	The 24th day for 96 deg.	,,	,,		144 deg.
25.	The 25th day for 80 deg.	,,	,,		30 deg.
26.	The 26th day for 32 deg.	,,	,,		56 deg.
27.	The 27th day for 23 deg.	,,	,,		12 deg.
28.	The 28th day for 15 deg.	,,	,,		26 deg.
29.	The 29th day for $5\frac{1}{26}$ deg.	,,	,,		$4\frac{2}{3}$ deg.
30.	The 30th day the moon is the god Anu.				

The fractions at the end of the tablet are hard to explain, and it is unfortunate that the month is not named during which the observations were made, and that we have no other tablet of a similar kind to compare with it. It will be noticed that here, as everywhere else in Babylonian mathematics, the soss or 60 was the unit, and also that the path of the moon was divided into 240 (60 × 4) degrees. This corresponds with an analogous division of the equator into 240°, η Piscium being 60°, γ Piscium (or rather α Pegasi) 80°, and so on. An inner circle was drawn within the equatorial and divided into 120 (60 × 2) degrees, a line passing through η Piscium being 30°, and 10° being marked for every 20° of the equator. The ecliptic, "the yoke of the sky" as it was picturesquely called, was divided into 360°, 30° for each sign.* It is curious that no trace is to be found of the 28 *nakshatras* or lunar mansions of Hindu and Chinese astronomy which have been so confidently assigned to a Babylonian origin. Should M. Biot, however, be right in holding that there were primarily but 24 of these, the four additional ones being added by the Chinese sage, Cheu-kung (B.C. 1100), it is possible that they might be connected with the 24 zodiacal stars which, according to Diodorus, were called "judges" by the Babylonians, 12 being north and 12 south.

The problem of calculating solar eclipses by tracing the shadow as projected on a sphere had also presented itself at an early period. Like eclipses of the moon, eclipses of the sun are spoken of as occurring either "according to calculation" or "contrary to calculation." In a report sent in to one of the later kings of Assyria by the State Astronomer, Abil-Istar states that a watch had been kept on the 28th, 29th, and 30th of Sivan, or May, for an eclipse of the sun, which did not, however, take place after all. The shadow, it is clear, must have fallen outside the field of observation. Besides the more ordinary kind of solar eclipses, mention is made of annular eclipses, which, strangely enough, are never alluded to by classical writers. It is interesting to find that observations were made as early as the time of Sargon of Agané on the varying colour of the sun, especially at the beginning of the year on the 1st of Nisan. Thus in one place we are told that the sun on that day was "bright yellow," in another place that it was "discoloured" (or rather "spotted").

Of the planets, only Mercury, Venus, Mars, Jupiter, and Saturn were known, besides the earth. These, however, excited great attention, and their phenomena were carefully studied. The movements of Venus and Mars especially attracted notice. Among the names given to Mars was that of "the vanishing star," in allusion to its recession from the earth, just as Jupiter was frequently called "the planet of the ecliptic," from its neighbourhood to the latter. The title of Mars just alluded to, however, raises the very interesting question whether the Babylonians had observed the phases as well as the movements of Venus and Mars. Now a report, taken from the "Observations of Bel," distinctly states that Venus "rises, and in its orbit duly grows in size," and this, in combination with the name of Mars as "the vanishing star," shows plainly that the phases of the two planets must have been noticed. Such a fact necessitates the existence of some kind of telescope, however rude; and Mr. Layard's discovery of a crystal magnifying lens at Nineveh indicates that such an instrument may have actually been in use.*

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* Literally, "becomes obscure."

* The Babylonian symbol for a degree was the star ✳).

The portion of Chaldean astronomy which was concerned with the planets was unnecessarily complicated by the habit of naming them from the fixed stars near which they happened to be at different times of the year, so that the same planet is often spoken of under varying names. Thus *Nibatanu* was properly Altair, but became a very common title of Mars. The number of the fixed stars observed by the Chaldeans was very great, and again suggests the use of something more than the naked eye. The principal stars had individual names, the rest being included in the constellations to which they belonged. In this way the heavens were mapped out long before the idea of a terrestrial atlas had suggested itself. The identification of the Chaldean constellations and fixed stars is of course a work of considerable difficulty, but the modern representatives of several of them have now been determined, and with the help of these and fresh astronomical texts, there is every reason to hope that our knowledge of the celestial globe of the Babylonians will be as complete as it is in the case of the Greeks and Romans.

A. H. SAYCE

COMTE'S PHILOSOPHY

The Positive Philosophy of Auguste Comte, freely translated and condensed. By Harriet Martineau. In Two Volumes, 8vo. Second Edition. (London: Trübner and Co., 1875.)

THE first edition of Miss Martineau's version of the "Positive Philosophy" was published in the autumn of 1853. The considerable space of time which has since elapsed cannot have been due to any defect in the adapter's work. So excellently were the translation and condensation accomplished by Miss Martineau, that Comte substituted her two volumes for his own six volumes, and since Comte's death the work has actually been retranslated into French. It does not give us a great idea of the demand for Comte's works in England, when we find that twenty-two years intervene between the first and second editions. At last, however, the work is re-issued in two handsome volumes, but we are not informed that any alteration at all has been made either in the matter or language of the work, and I have not been able to detect a difference even in a word. The appearance of this new edition nevertheless affords an opportunity for a few remarks upon the value and pretensions of the "Positive Philosophy."

It has been asked "What's in a name?" As regards the positive philosophy, it may be answered that there is a great deal in the name. The name Positive is an admirable *question-begging epithet.* Everything which Comte wished to stamp with his approval, and make a part of his system, he called positive, and a formidable list of new names was invented. We have Positive Philosophy, Positivism, Positivity, Positive Method, Positive Polity, Positive Morality, and even Positive Practices. It would be much more correct to say Comte's Philosophy, Comtism, Comte's Method, Comte's Polity, Comte's Practices, because I believe it is impossible to attribute any invariable meaning to the word Positive, as used by Comte, except that it meant what belonged to his system. Nevertheless, the word was of inestimable value to Comte, because it enabled him to represent all his own views, some being of the most peculiar character, as the natural outcome of the Baconian Philosophy.

We frequently find Comte stating, in the frankest manner, that there was nothing new in the idea of a positive philosophy. Bacon and Descartes (vol. ii., pp. 381, 386, &c.) were the two great legislators of the philosophy. Even the common sense of ordinary thinkers contains all the elements of Positivism, provided that absurd metaphysical and theological ideas do not obscure them. Through Hume, Brown, and a few other philosophers, the pure method of positivism descended to Comte, whose mission it was to develop a complete system of positive thinking. When we attempt to find a clear definition of what the positive method is, it appears to be simply synonymous with the scientific method of induction, resting upon facts. Having thus invested himself with the prestige of whatever is best in the results of modern science, Comte proceeds to deliver at full length his own ideas of the origin and progress of civilisation, the grounds of morality, the best form of government, and the coming system of religious worship. All these ideas, being called positive, are of course the necessary outcome of the pure scientific method.

The following is one of the clearest statements, which I can find, of the nature of the positive method (vol. ii. p. 424):—"The Positive Philosophy is distinguished from the ancient . . . by nothing so much as its rejection of all inquiring into causes, first and final; and its confining research to the invariable relations which constitute natural laws. . . . We have accordingly sanctioned, in the one relation, the now popular maxim of Bacon, that observed facts are the only basis of sound speculation; so that we agree to what I wrote a quarter of a century ago, —that no proposition that is not finally reducible to the enunciation of a fact, particular or general, can offer any real and intelligible meaning. On the other hand, we have repudiated the practice of reducing science to an accumulation of desultory facts, asserting that science, as distinguished from learning, is essentially composed, not of facts, but of laws, so that no separate fact can be incorporated with science till it has been connected with some other, at least by the aid of some justifiable hypothesis." Now this passage not only contains very good sense, but it may be regarded as a most clear statement of what correct scientific method aims at, the ascertainment of general laws. But there is nothing whatever in this to distinguish the positive method from that pursued by all scientific inquirers who have any share of the spirit of Galileo, or Gilbert, or Newton, or Hooke, or Lavoisier, or Laplace, or Faraday. The question really is, then, whether Comte, having properly formulated the method of scientific inquiry, knew how to apply it in regions where he was not led by greater minds. There is no doubt that Comte possessed a remarkably extensive and generally accurate knowledge of mathematics, astronomy, and many portions of physics and chemistry, as developed in his day. The first part of his work is therefore comparatively free from objection, and consists to a great extent of an interesting and able review of the progress of physical science.

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* A broken tablet I have come across seems to record a transit of Venus across the sun. It is to be hoped that Mr. Smith will before long succeed in bringing to England the remainder of the Kouyunjik Library. At present a tablet is often broken off at its most interesting part, while the corresponding fragment is still lying under the soil on the banks of the Tigris.

Incidentally I may remark, that Comte, while continually sheltering himself under Lord Bacon's great name, appears to have known little or nothing of Bacon's works. If there was one thing which Comte abjured, it was the inquiry into causes, whereas Bacon quotes approvingly the old dictum that "truly to know is to know by causes." Every reader of the "Novum Organum" must be aware that Bacon deals not only with causes, but with still vaguer ideas, Forms, Natures, Essences, terms so metaphysical that even the editors of Bacon hardly pretend to make out clearly what they mean. The following is a characteristic extract from the second book of the "Novum Organum" (Aphorism iv.):—"The true form is such that it deduces the given nature from some source of essence which is inherent in things, and is better known to nature, as they say, than Form is. And so this is our judgment and precept respecting a true and perfect axiom for knowledge, that another nature be discovered which shall be convertible with the given nature, and yet be a limitation of a more general nature, like a true genus." It is possible that Bacon knew what he meant, but his own employment of his "true and perfect axiom" was no more happy than I hold Comte's application of his positive method to be.

It is of course impossible to show in a single brief article how crude and unscientific were Comte's results when he applied his method to new fields of research, especially in Sociology. One of his supposed greatest discoveries was the philosophical law of the succession of three states: the primitive theological state, the transient metaphysical, and the final positive state. This is one of those vague and hasty generalisations which have the worst scientific vice of being incapable of precise verification. The theory can be stretched, like india-rubber, to cover any difficulties. If we object that the Hebrews were from the earliest historical times Monotheists, and have so continued to the present day, we are told that they were *prematurely monotheistic*, and are left to imagine that they will ultimately become positivists. What sufficiently condemns Comte's laws of evolution is that they led him away from the doctrines of evolution as now established by Darwin and Spencer, and their followers. Comte was well acquainted with Lamarck's views, which he discusses in Book V. chap. 3, coming to the unfortunate conclusion (vol. i. p. 345) that in every view Lamarck's conception is to be condemned, and "that species remain essentially fixed through all exterior variations compatible with their existence." In the beginning of the fifth chapter of the sixth book, too, we find a passage which entirely cuts Comte off from any share in the sociological doctrines of Spencer. "Gall's cerebral theory," he says (vol. ii. p. 105), "has destroyed for ever the metaphysical fancies of the last century about the origin of man's social tendencies, which are now proved to be inherent in his nature, and not the result of utilitarian considerations." It is highly remarkable that, though the germs of the new philosophy of evolution had been put afloat by the elder Darwin, Lamarck, Malthus, and others, both Comte and his admirer, John Stuart Mill, entirely failed to appreciate their value.

There is no doubt that Comte had very wide and general views as to the possibility of creating great bodies of social science, described by various combinations of the adjective Positive, such as Positive Morality, Positive Polity; but I quite deny that he had any true conception of the proper way of going about the work. It is impossible that he should have, because he altogether abjured and ridiculed that branch of mathematical science, namely, the theory of Probability, by which alone we can approach the scientific investigation of the complex condition of a nation. He says (vol. ii. p. 416): "Mathematicians drop the supposition of natural laws as soon as they encounter phenomena of any considerable degree of complexity, and especially when human action is in any way concerned; as we see by their pretended calculation of chances, through a special application of analysis—an extravagance which is wholly incompatible with true positivity, but from which the vulgar of our algebraists still expect, after a century of wasted labour, the perfecting of some of the most difficult of human studies." It becomes hardly possible to treat Comte's pretensions seriously, when we contemplate this intellectual freak by which he rejects the theory which is becoming more and more the basis of all exact science. The more exact and perfect, in fact, a science becomes, the more complete is the application of the rules derived from the theory of probability. In the computations at Greenwich and other astronomical observatories, they are used in almost every reduction. Nothing is more accurate than a good trigonometrical survey, and yet there is no work to which the theory of chance is more elaborately applied. In proportion as chemistry and physics become exact and methodical sciences, they also resort to the theory of chance, as we see in the researches of Sir B. C. Brodie, or the elaborate labours of Prof. W. H. Miller on standard weights and measures.

As to social science, the Method of Means and the law of divergence from an average, founded on the theory of probability, are simply the alpha and omega of scientific method. We cannot stir a step in any branch of statistical inquiry without drawing an average, and we cannot do this unless we accept the theory which Comte ridiculed. Quetelet is the true founder of exact social science, and his long labours consisted in the unwearied application of the doctrine of chance to vast bodies of statistical facts. In Mr. Francis Galton's works we find the same true method carried out with perfect appreciation of its value.

I might go on to point out, again, that the one branch of social science which most early assumed a partially scientific form, namely, political economy, was that to which Comte entirely refused his *imprimatur*. He never would allow it to be called Positive, though he predicted that in the positive era the world would be governed by bankers. Criticism, however, is disarmed when we consider the vagaries to which the positive method is supposed to have led its great expositor.

W. STANLEY JEVONS

INTERNATIONAL METEOROLOGY

Report on Weather Telegraphy and Storm Warnings to the Meteorological Congress at Vienna, by a Committee appointed at the Leipsig Conference.—Report of the Proceedings of the Conference on Maritime Meteorology, held in London, 1874. (Published by authority of the Meteorological Committee, 1875.)

THE first of these reports is a clear and admirable statement drawn up by Dr. G. Neumayer, of Berlin, secretary to the Committee, of the present position of Meteorology with reference to storm warnings. In this light we recommend it, as well as the appendix which gives the opinions of nearly all our best meteorologists on this important question, for attentive perusal. It is a significant fact, as marking the change of opinion which has taken place since the Dundee meeting of the British Association, that the Committee declare it to be desirable that in all countries in which up to the present time systems of storm warnings have not been organised, steps leading to such an organisation should be taken as soon as possible. What is now required is the further development of the system as regards the principles on which it is based, and its practical application to other public interests than those of commerce and navigation.

The Maritime Conference which met in September 1874 did some goodwork towards securing for meteorology greater exactness and uniformity in observations made at sea—not the least important consideration being the number of countries represented at the Conference, all of which, it may be inferred, will be guided by the decisions arrived at. Of the improvements effected on the Brussels Abstract Log may be noted the recording of the direction and force of the wind as at the time of observation, and not as estimated for a certain number of previous hours, and the recording of the upper and lower clouds in separate columns. The notation of clouds from 0, a clear sky, to 10, an entirely clouded sky, is also an improvement as being in accordance with the procedure now adopted on land. As regards the discussion of ocean statistics, the decision is in every way admirable, viz., that the observations and results be published in such a manner that every foreign institute may be able to incorporate them with its own observations and results; that, to this end, the number of observations, as well as the means deduced from them, be preserved for single degrees square, and that, whatever charts be published, the results for single degrees square be printed in a tabular form.

In the proposed English instructions for keeping the log, we regret to see it stated that for all except wind observations it is sufficient to observe at the four-hourly periods, viz. at 4, 8, 12, A.M. and P.M. A strong recommendation should have been made to make the 10 A.M. and P.M. observations, particularly with the view of arriving at a correct knowledge of the distribution over the ocean of the daily barometric fluctuation which is of so great importance in its connection with atmospheric physics. Since by the hours recommended, no systematic observation will be made from 8 to 12 A.M. and P.M., the two daily maxima of atmospheric pressure will remain wholly unobserved, even approximately.

The box for protecting the thermometers on board, figured at p. 53 of the Report, is of faulty construction—the louvres being single and too wide apart to afford the required protection from the disturbing influences which are so great on board ship. A double-louvred box of the pattern, for instance, of Stevenson's, now so extensively used on land, is indispensable. An arrangement of this sort is the more desirable when it is considered how important it often is in practical navigation to know with exactness the difference between the temperature of the air and that of the sea.

It is with much satisfaction that we notice at pp. 19 and 20, the resolutions passed with reference to the co-operation of the navies of different countries in the working out of the problems of ocean meteorology. Doubtless the time will soon come when the navy will occupy, in practical ocean meteorology, the place occupied in land meteorology by the Central Office in prosecuting instrumental and physical researches; and when it will seriously grapple with the difficult problems of making *real* wind, rain, and hygrometric observations at sea; make hourly observations for determining the constants of temperature, humidity, and pressure over the ocean; and make observations at outlying stations, and observations at 0h. 43m. Greenwich mean time, in connection with the United States Signal Office; as well as collect data on matters more immediately connected with physical geography, such as those with which the *Challenger* has enriched physical science. Towards the bringing about of these desired results, the resolutions of the Conference are well-timed.

OUR BOOK SHELF

Rambles in search of Shells. By J. E. Harting, F.L.S., F.Z.S. (London: John Van Voorst, 1875.)

SAYS the author of this small work, in his introduction: "It has often been a matter of surprise to us that the study of the land and freshwater shells has not more votaries, especially amongst the fair sex. The subject may be easily coupled with botany, being, as it were, nearly associated with it; for, whether we ramble on the downs, in the woodland, or in the marsh, in search of any particular plant, we seldom fail to find in close proximity to it some species or other of mollusca which claims its shelter or support." The large field of entertaining detail—comparatively little trodden, except by the erudite few—which is opened up by a study of shells and their inmates, cannot be better entered than by a perusal of the work before us. Mr. Harting has a happy way of placing the rudiments of a science in a light which goes far to remove the comparative uninterestingness of its bare facts. These latter he intersperses with references to easily appreciated and well-known collateral associations, which retain the attention of the reader, at the same time that nothing is taught but trustworthy and important principles. It is evident that, to the beginner, the classification adopted by systematists is comparatively unintelligible, and often only confusing. That based upon the localities and characteristic soils which the different species inhabit, being at first sight much the more simple, is the one adopted. Accordingly, we find chapters devoted to the shells found on the London Clay, others on chalk soils, &c.; the less common species, from whatever soil, being described in proximity to their better known and nearest allies. Several carefully-drawn coloured plates of the species described greatly facilitate the identification of each. A useful appendix also is a list of the local catalogues of the native land and freshwater mollusca, with the assistance of which the study, commenced in the work itself, can be extended by the enthusiastic local collector. The number of species described as undoubtedly British is one hundred and twenty, including the slugs, which, "though generally regarded as shell-less, have the shell placed beneath the mantle."

A Manual of the Mollusca. By S. P. Woodward. Third Edition. (London: Lockwood and Co., 1875.)

IN noticing a third edition of the late Mr. S. P Woodward's well-known "Manual of the Mollusca," our object is only to indicate wherein it differs from its predecessors. The body of the work is unaltered; whilst the new editor, Mr. Ralph Tate, in order to bring the work up to the present state of our knowledge, has added an appendix, containing the description of those recent and fossil genera which, either from more recent discovery or oversight, are not to be found in it. This appendix, with its separate index, occupies eighty-five pages, and is illustrated with twenty-seven woodcuts, including drawings of *Clydonites costatus*, *Cochloceras fischeri* (Hauer), *Eucyclus goniatus* (Desl.), *Nucleospira ventricosa* (Hall), &c. Its separate existence we do not object to, on account of the expensive typography of a work of the kind; nevertheless, the outlay involved in an incorporation of the two indexes into a single whole would have been fully made up for by the extra facility of reference afforded, and the diminution in the chance of any additional remarks on previously described genus being overlooked. In the preface to the second edition, which is retained in that under notice, it is remarked that "the chapter on Tunicata has been omitted, since they are more nearly allied to the Polozoa than to the Mollusca proper, and since the Molluscoidan group would have made the work inconveniently bulky." Such being the case, we cannot help asking why the Brachiopoda are not also removed. Is it not because they have shells, whilst the Ascidians are deficient in indestructible parts; not, by the way, that Ascidians are Molluscoidan now-a-days. Additional remarks will be found on the nature of *Belemnites*; that *Crioceras* must merge into *Ancyloceras* is shown to be certain; the genera *Vermetus* and *Siliquaria* are placed in a family by themselves, at the same time that their differences from the mimetic *Serpulidæ* are explained. Several of the families are re-arranged, at the same time that the newly added genera are introduced. The work with the appendix is as accurate a representation of the state of conchology in 1871 as was the first edition on its publication. We put it thus because we can find no difference between this third edition and the second, which has latterly been been bound up with Mr. Tate's appendix in exactly the same form as it appears in the newly produced work.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Oceanic Circulation

I HAVE just read Dr. Carpenter's letter in NATURE (vol. xii. p. 454) in reference to my paper on the *Challenger's* crucial test of the wind and gravitation theories of oceanic circulation, read before the British Association, and am somewhat astonished at the nature of the objections which he advances.

"The doctrine," says Dr. Carpenter, "to which he (Mr. Croll) applied his test, was not mine, but a creation of his own. For his whole argument was based on the assumption that the ocean is in a state of static equilibrium; whereas the theory I advocate is, that the ocean never is and never can be in a state of equilibrium, so long as one part of it is subjected to polar cold and another to equatorial heat, but that it is in a state of constant endeavour to recover the equilibrium which is as constantly being disturbed."

Those who were present at the meeting and heard my paper read, or who have since seen it in the September number of the *Philosophical Magazine*, will no doubt feel surprised that the following paragraph should have escaped Dr. Carpenter's notice:—

"It will not do as an objection to assert that according to the gravitation theory the ocean never attains to a condition of static equilibrium. This is perfectly true, as I have shown on a former occasion;* but then it is the equator that is kept below and the poles above the level of equilibrium; consequently the disturbance of equilibrium between the equatorial and polar columns would actually tend to make the difference of level between the equator and the Atlantic greater than 3½ feet, and not less, as the objection would imply."

If Dr. Carpenter will refer to my examination of the mechanics of the gravitation theory in the *Philosophical Magazine* for October 1871, "Climate and Time," chaps. ix., x., alluded to in the above paragraph, he will find page after page devoted to prove that a constant disturbance both of *level* and of *static equilibrium* is a necessary condition to circulation by gravity. Physicists may differ from me in regard to whether or not the present difference of temperature between the ocean in equatorial and polar regions is sufficient to produce circulation, but I do not expect that anyone familiar with mechanics, *who has been at the trouble to read what I have written on the subject*, will do so materially in regard to the way in which difference of temperature is conceived to produce motion.

It is singular that Dr. Carpenter should not have observed that his objection strengthens my argument instead of weakening it. For if it be true that the equatorial column, though in a state of constant upward motion, never attains to the height required to balance the polar column, then it must follow as a necessary consequence that the rise from the equator to latitude 38° in North Atlantic must be greater than I have estimated it to be; and, therefore, so much the more impossible is it that there can be any surface flow from the equator to the pole due to gravity.

The next objection is as follows:—"The only objection raised by Mr. Croll which has even a show of validity is based on the supposed 'viscosity' of water, which he asserts to be sufficient to prevent the disturbance of thermal equilibrium from exerting the effect which the gravitation theory attributes to it."

What possible connection can "viscosity" have with the crucial test argument? Suppose water to be a perfect fluid and absolutely frictionless: this would not in any way enable it to *flow up-hill*.

The crucial test argument brings the question at issue, in so far as the North Atlantic is concerned, within very narrow limits. The point at issue is now simply this: *Does it follow, or does it not, from the temperature-soundings given in Dr. Carpenter's own section, that the North Atlantic at lat.* 38° *is above the level of the equator?* If he or anyone else will prove that it does not, I shall at once abandon the crucial test argument and acknowledge my mistake; but if they fail to do this, I submit that they ought at least in all fairness to admit that in so far as the North Atlantic is concerned, the gravitation theory is untenable.

The Atlantic column is lengthened by heat no less than eight feet above what it would otherwise be were the water of the uniform temperature of 32° F., whereas the equatorial column is lengthened only four feet six inches. The expansion of the Atlantic column below the level of the bottom of the equatorial not being, of course, taken into account. How then is it possible that the equatorial column can be above the level of the Atlantic column? And if not, let it be explained how a surface-flow from the equator pole-wards, resulting from gravity, is to be obtained. JAMES CROLL

Edinburgh, Sept. 29

Dehiscence of *Collomia grandiflora*

THE following account of some observations of mine on the dehiscence of *Collomia grandiflora* may possibly prove interesting to some of your botanical readers. I can find no allusion to the singular mode in which the capsules as well as the seeds of this plant become liberated. The fruit is a three-celled capsule, and is almost wholly included within the tube of the calyx. When quite ripe it is of a pale straw colour, and becomes cartilaginous and highly polished, as does also the internal surface of the calyx tube. The latter is ribbed with fifteen prominent lines disposed in threes, each set pertaining respectively to the five sepals, and extending into their free portions. These ridges may possibly help to give direction to the capsule during its exit. Dehiscence

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* Phil. Mag., Oct. 1871; "Climate and Time;" chap. ix.

takes place loculicidally, and the three dark-brown seeds, one in each cell, are exposed to view. It is at this stage that the phenomenon in question may be observed. The pressure exerted by the smooth sides of the somewhat obconical capsule against the equally polished surface of the calyx-tube occasions the rupture of the capsule from the base of the calyx, and its more or less rapid expulsion into the air with its three seeds. The latter, which are at this time free within the cells of the capsule, are carried to greater distances on account of the smaller amount of resistance they offer to the air by reason of their shape and weight; the action, in fact, being not altogether unlike that of the discharge of a cartridge and its contents from a rifle. The suddenness of the explosion depends very much on the state of the atmosphere at the time. On a hot day I have observed several instances of spontaneous discharges, whilst a slight touch only was necessary for the explosion of the remaining capsules whose dehiscence had already commenced. Many of the seeds were observed adhering to the upper leaves and calyx-segments, which are thickly covered with glandular hairs of a remarkably viscid nature. Contact with these moist bodies very soon induces the outgrowth of those curious and beautiful spiral hairs for which the seeds of this and a few other plants are remarkable, and thus they become doubly secured by adhesion. I have noticed in some cases when seeds adhere to the flat surface of a viscid leaf, that this outgrowth assumes a definite outline extending all round the seed in the form of a flat membranous expansion, and these, on removal, recall forcibly the appearance of ordinary winged seeds, like those of *Lepigonum marginatum*, for instance. Can this attachment be of any use to the seeds or to the plant itself by feeding on the nitrogenous products of their decomposition? Although I have observed a few of these attached seeds undergoing partial decay, yet, from the nature of their hard horny perisperm, it is not reasonable to suppose that it can take place to any great extent, unless the viscid secretion from the glands is able to render this substance sufficiently soluble for the purpose. If, however, a certain proportion do become sacrificed for the good of the plant, we can understand the object not only of the delicate spiral hairs for ensuring firm attachment, but also that of the explosive process, by means of which a certain number of seeds are conveyed beyond the reach of the viscid surfaces, and falling to the ground, are available for the reproduction of the plant. *Saxifraga tridactylites* might be mentioned as another instance of a viscid plant with the habit of retaining the seeds on its glandular parts; the much larger quantity, however, produced by this latter plant in proportion to what can be required for reproductive purposes would seem to do away with the necessity for any sudden mode of expulsion. Like most plants with sticky glandular hairs, the viscid parts of this Collomia may be seen covered with small insects in various stages of decomposition.

It might be asked, "What advantage can it be for an annual plant to feed on its own seeds, the production of which is the completion and, in a certain sense, the object of its existence?" I would suggest, though with diffidence, the possibility of certain annuals being raised by such means to a higher state of existence as biennials or perennials, in which condition they might or might not require the continued assistance of glandular hairs or other such contrivances. This might explain the occurrence of hairs on certain parts of plants either constantly present or at particular times of their life; such, for instance, as those on the first leaves of the turnip plant, and many other examples could be given, in the case of which we might suppose that the possession of such hairs, or whatever they may represent, have ceased to be required.

There does seem to be some sort of general relation as to the degree of hairiness between annuals, biennials, and perennials, and which often becomes apparent during the development of many plants which in their adult condition are destitute of hairs. On this hypothesis it seems to me conceivable that many of our large glabrous-leaved trees may have originated from hairy or glandular annuals, dependent, perhaps, more or less on aërial nitrogenous food. In any case it is interesting to investigate the true purpose—for such there must be—of the elaborate machinery of traps and spring-guns as displayed in the life of this Collomia.

J. F. DUTHIE

Royal Agricultural College, Cirencester

P.S. Since the above was written I have observed the effect of placing a few of the empty expanded capsules in water. In a short time (about half an hour) their valves became completely contiguous, and they presented the same appearance as they did shortly before dehiscence, with the exception of a transparency due to their containing water instead of seeds. This sensitiveness to the action of moisture is clearly a provision for preventing the filamentous outgrowth from the surface of the seeds whilst in the capsule

J. F. D.

Lunar Phenomena

I HAVE pleasure in forwarding a brief account of facts relating to two very remarkable protuberances which were observed on the moon's disc in the Gulf of Siam, by Mr. E. C. Davidson, Telegraphic Engineer, and myself.

H.S.M.'s guard-ship *Coronation* (Champon Bay), July 13 (civil time), in lat. 10° 27′ 40″ N. and long. 99° 15′ E., at midnight, the moon bore S.W. by W. magnetic, and its altitude was about 20°, when a prominent projection was seen with the naked eye on the moon's upper limb. The best glasses on board were soon brought to bear upon it, and the enclosed sketches * (with due regard to proportion) were carefully made on the spot.

The protuberance, in colour, was similar to that of the moon.

On July 14, at 8 P.M., the moon was observed perfectly clear, but without a vestige left of the protuberance of the previous night. At this hour, however, a small one was noticed in a different position of the limb.

This also had disappeared before the moon rose on the evening of the 15th inst., when it finally presented its usual unbroken appearance.

A. J. LOFTUS

Champon Bay, Gulf of Siam, July 16

The Strength of the Lion and the Tiger

IN NATURE, vol. xii., p. 474, in a review of Dr. Fayrer's book on the tiger, doubts are thrown by the reviewer on the statement that the tiger is stronger than the lion. Dr. Fayrer's statement cannot be contradicted by any person well acquainted with both animals. In my book on "Animal Mechanics," published in 1873, I have proved, p. 392, that the strength of the lion in the fore limbs is only 69·9 per cent. of that of the tiger, and that the strength of his hind limbs is only 65·9 per cent. of that of the tiger.

I may add that five men can easily hold down a lion, while it requires nine men to control a tiger. Martial also states that the tigers always killed the lions in the amphitheatre. The lion is, in truth, a pretentious humbug, and owes his reputation to his imposing mane, and he will run away like a whipped cur, under circumstances in which the tiger will boldly attack and kill.

At p. 482 you state that Dr. Bolau, of Hamburg, is about to publish an account of the anatomy of a gorilla which nearly reached Hamburg alive, and was preserved in spirits. Your readers will be glad to learn that he has been anticipated by Prof. Macalister, of Trinity College, Dublin, who has already published a full account of a similar animal, which nearly reached Liverpool alive some years ago, and was dissected by myself and Dr. Macalister. A comparison of his muscles with those of man, chimpanzee, and hamadryas, will be found in my "Animal Mechanics," p. 404 *et seq.*

SAMUEL HAUGHTON

Trinity College, Dublin, Oct. 1

A Snake in Ireland

THE enclosed letter to the editor of the Irish *Daily Express* may excite speculation as to how the snake got where it was found. The fact is worthy of record, at any rate, that a snake has been caught in Ireland. What would St. Patrick say?

> "Sir,—My gardener this morning killed a large snake in the garden here, measuring five feet long by three inches in circumference. It has a black back, with light yellow belly; I do not know what species it belongs to, but have preserved it in spirits. Is it not very rare to find such in Ireland?—Your obedient servant, "FRANCIS WM. GREENE.
>
> "Kilranalagh, Baltinglass, Co. Wicklow, Sept. 11."

I have not seen it, but my correspondent Lady M. has it in her possession, and remarks that its head is very small and its nose pointed; it is quite five feet long, black, and the colour of ashes underneath. It appears by a letter from Mr. Greene, "that a gentleman brought two Indian snakes to Ballinrodan, both of which escaped six or seven years ago; one of them was found half eaten by a pig shortly afterwards, and this might be the other, though how it lived through the winters I do not know."

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* The sketches are not clear enough to be reproduced.

It would be interesting to ascertain whence the snake came and how it found its way to the proscribed island.

London, Sept. 28 J. FAYRER

Origin of the Numerals

IN the novel "David Elginbrod," by George Macdonald, p. 45, is a suggestion of the origin of the forms of the numerals in daily use, very similar to that indicated by Mr. Donnisthorpe in last week's NATURE, p. 476. The disposition of the lines in some of the figures is very ingenious. G. W. WEBSTER

Chester, Oct. 4

IF your correspondent will refer to Leslie's "Philosophy of Arithmetic," p. 103 *et seq.*, he will find that very much is known respecting the origin of the numerals. By referring to p. 107, same work, he will find that the numerals he gave are wonderfully like the Sanskrit.

Newcastle-upon-Tyne, Oct. 4 WM. LYALL

Scalping

MR. CHARLES C. ABBOTT, in NATURE, vol. xii. p. 369, wishes to learn what other men, if any, besides the North American Indians, have the practice of scalping among them. The question is answered in Southall's "Recent Origin of Man," chap. ii. p. 40. "In this connection we may mention that the custom of *scalping* is not peculiar to the American Indians. Herodotus mentions that it was one of the most characteristic practices of the ancient Scythians. But this is not all: it is stated that the practice prevails at this day among the wild tribes of the frontier in the north-eastern district of Bengal. The *Friend of India*, commenting on this statement, adds: 'The Naga tribes use the scalping-knife with a ferocity that is only equalled by the American Indians, and the scalps are carefully preserved as evidences of their prowess and vengeance over their enemies. On the death of a chief, all the scalps taken by him during his warlike career are burned with his remains.'" G. PEYTON

University of Virginia, U.S.A., Sept. 22

OUR ASTRONOMICAL COLUMN

THE DOUBLE STAR Σ 2120.—As mentioned last week, M. Flammarion advocates the binary character of this star, identifying it, as Sir John Herschel had already done, with H. III. 89. Sir W. Herschel's observation runs thus:—

> "III. 89. Ad 63^{am} Herculis. In linea per δ et ε ducta.
> 1782 Nov. 26. Double. About 4 degrees from δ towards ε Herculis, near the 63rd. Very unequal. L. r.; S. r. Distance 11″ 53‴. Position 47° 48′ n. following."

There is a contradiction here; a position "4 degrees from δ towards ε Herculis," which pretty well agrees with that of Σ 2120, would not be near 63 Herculis, which is little more than 1° s.p. δ.

The formula given in NATURE, vol. xii. p. 147, assigns for the position of the small star at Sir W. Herschel's date—

Angle ... 36° 39′ ... Distance 10″·72
The observation has ,, ... 42 12 ... ,, 11 ·18

It is by the difference between these positions, which however it may be remarked is not larger than we occasionally meet with on comparing Sir W. Herschel's measures with recent ones, in cases of stars which there is reason to suppose merely optically double, that the binary nature of the object is considered to be proved by M. Flammarion, as it had been by Sir John Herschel in the paper upon his father's measures, which appears in vol. 35 of the "Memoirs of the Royal Astronomical Society." Until that single observation is supported by curvature in the path of the small star subsequent to its nearest approach to the primary, which if this be really a binary system must probably become sensible within a few years from the present time, the suspicion of rectilinear motion of the small star as the cause of the change of position, representing as it fairly does the measures between 1829 and 1873, is not one perhaps that can be legitimately abandoned. The apparent fixity or nearly so of the principal component to which reference was made in our former remarks, is supported by Dr. Engelmann's comparison of the place deduced from meridian observations at Leipsic in 1867, with Struve's position in "Positiones Mediæ," for which the mean date is 1836·1; for secular proper motion he found $\Delta\alpha = +0^{s}\cdot192$, $\Delta\delta = +2''\cdot40$—very insignificant quantities, and showing that if proper motion, as we have surmised, enters into the question, it is mainly the smaller star that is affected by it. M. Flammarion, relying as stated upon Sir W. Herschel's measure of 1782, concludes: "C'est donc un systême orbital très-incliné, et c'est peut-etre celui dont l'aspect ressemble le plus aux systêmes de perspective." We leave it for the measures that may be made during the next few years to decide between these opinions.

THE NEBULA IN THE PLEIADES.—In No. 5 of "Publicazioni del Reale Osservatorio di Brera in Milano," Herr Tempel has laid down the stars in the Pleiades, from the "Durchmusterung," and traced the outline of the nebula near Merope as it appeared to him with a magnifying power of twenty-four on a telescope of four inches aperture. The outline is shown to be elliptical, one extremity of the longer axis, the northern one, at Merope, and the inclination of this axis to the circle of declination about 18°, so that as referred to Merope, the angle of position of the longer axis is 198°; the greatest and least diameters of the ellipse are roughly 35′ and 20′.

M. Wolf, of the Observatory of Paris, observing with the telescope of $0^{m}\cdot31$ aperture in March 1874, perceived two nuclei, one almost concentric with Merope, the other and brighter of the two at a distance of about seven seconds, on the same parallel, following. From the month of November 1874 to the end of February 1875 the nebula could not be seen notwithstanding the very favourable atmospheric conditions, and at the same time M. Stéphan was unable to detect it with the telescope of $c^{m}\cdot80$. M. Wolf concludes that the nebula is certainly variable, and that its period is pretty short.

Herr Tempel remarks that generally the nebula has been much more readily seen with small telescopes than with large ones, and doubt has been expressed as to any real variability of light; yet it is not easy to understand, except upon this supposition, why the nebula should be visible at certain times in a particular telescope and invisible at others, the circumstances of sky appearing to be about the same in all cases.

This nebula was first remarked by Herr Tempel, at Venice, on the 23rd of October, 1859.

THE SATELLITES OF URANUS AND NEPTUNE.—An elaborate and highly interesting investigation of the elements of these satellites from observations with the 26-inch equatorial of the United States Naval Observatory, Washington, and of the masses of the primaries thereby indicated, has been received from Prof. Newcomb during the past week; it forms an appendix to the Washington Observations for 1873. The most probable value of the mass of Uranus derived from these observations is $\frac{1}{22600}$, with a probable error of 100 in the denominator of the fraction. For Neptune the value of the mass by satellite-observations is $\frac{1}{19380}$; the mass deduced by Prof. Newcomb from the perturbations of Uranus having been $\frac{1}{19700}$: the value resulting from the satellite-observations is preferred. A further account of this important memoir by the eminent American astronomer is reserved for next week.

THE MINOR PLANETS.—M. Leverrier's *Bulletin International* of Sept. 30 mentions the observation of a small planet, on Sept. 21st, by M. Perrotin at Toulouse, 13th mag., which may possibly be new, though at present there is a chance of its identity with No. 77, which is in the same quarter of the sky and has not been observed since 1868, or with No. 137, of which no elements have yet appeared. Its place at 8 P.M. was in R.A. 23h. 16m. 8s., and N.P.D. 95° 12′.

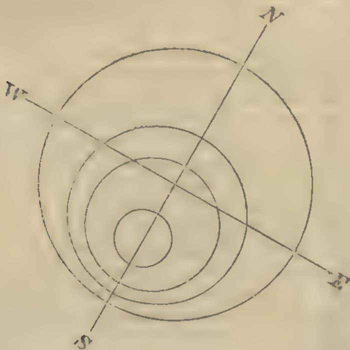
THE TOTAL SOLAR ECLIPSE OF 1878, JULY 29.—The *American Ephemeris* for 1878 is published. The elements of the total eclipse of the sun on July 29, derived from the Lunar Tables of Prof. Peirce, which are adopted for the calculations in that work, are almost identical with those of the *Nautical Almanac*, founded upon the Tables of Hansen, Denver. Colorado appears to be one of the principal places within the limits of the shadow, though some distance from the central line. The sun will be centrally eclipsed on the meridian, according to the *American Ephemeris*, in long. 139° 8′ W., lat. 60° 32′ N.; and according to the *Nautical Almanac*, in long. 139° 10′ W., lat. 60° 27′ N.

MAYER'S METHOD OF OBTAINING THE ISOTHERMALS OF THE SOLAR DISC

THE short notice which I published of my "Discovery of a method of obtaining thermographs of the isothermal lines of the solar disc" was so concisely written that the precautions which are necessary in this new method of research were omitted; but as the republication of my paper in NATURE (vol. xii. p. 301) and in other European journals may induce those engaged in astronomical physics to try the process, I think it proper that I should call attention to some very important experimental conditions to be fulfilled before accurate results can be reached.

1. Special precautions must be taken to prevent currents of air from acting on the film of double iodide.

2. If the image of the sun be formed on the blackened side of the paper, it is absolutely necessary that uniformity should be given to this coating of lamp-black. So difficult is this to achieve that I have generally formed the sun's image directly on the film of iodide. Slight irregularities in this film do not appear to affect the form of the isothermals; but the latter follow irregularities in the smoked surface.



3. The most important, and indeed absolutely essential, condition in these experiments is that the image of the sun shall be formed on a truly *horizontal surface;* for the centre of gravity of any isothermal formed on an *inclined* surface is always *above* the centre of the sun's image and in a vertical plane passing through this centre. Hence all isothermals thus formed are very excentric when referred to the sun's centre. They are also elliptical. The accompanying figure gives isothermals obtained on an inclined surface. *N S* is the solar axis. On obtaining these same isothermals on a horizontal surface they were, as near as could be seen, circular and concentric with the sun's image.

Of the influence of an inclined surface in displacing the isothermals there can be no doubt, and the same action has effected all of the results which have been obtained in the employment of thermopiles in connection with the sun's image received on screens attached to equatorial telescopes. This displacement would mislead an observer, and would cause him to be of the opinion that there existed a decided difference of temperature between the north and south solar poles, and between the portions of the periphery of the sun's image near the poles and near the solar equator. Do not these facts reached by me explain the difference in the results obtained by Secchi and Langley?

The above effects of inclined surfaces appear to be caused by a film of hot air which flows up over these surfaces, and especially on the lower surface of the screen. If the sun's image is received on a film of iodide enclosed between plates of glass or of mica, the excentricity of the isothermals is hardly apparent at first; but after some time it appears, produced by the action of the ascending film on the surface of the glass.

The proper method of research is to use a simple Fahrenheit's heliostat with a good plane mirror, and to throw the solar rays in the direction of the polar axis of the instrument. These rays traverse lenses of from 12 to 30 feet focus, and just before they have converged to form the solar image they are reflected perpendicularly, by another plane mirror, on to the horizontal surface of the iodide.

ALFRED M. MAYER

FAYE ON THE LAWS OF STORMS [*]

Examination of the Theory of Aspiration.—After a somewhat detailed account of opinions held regarding waterspouts in the prehistoric and Roman epochs, and from the sixteenth century downwards, all agreeing in this, that the water of the sea is sucked up to the clouds by these meteors (Fig. 6), M. Faye inquires, How then could it be doubted that waterspouts, and consequently tornadoes, typhoons, &c. are simply phenomena of aspiration?[†] Such has been in reality, since the time of Franklin, the point of departure for meteorologists; and hence the prevailing notions regarding hurricanes, that they are centripetal and formed by horizontal currents of air flowing from all quarters towards the centre of aspiration.

Clearly in this case the conclusions have not been drawn with the caution which science demands. To accept, with the eyes shut, the most astounding assertions without examination or verification; to believe, for example, that a waterspout could suck up the water of the sea to a height of 2,000 feet when the most powerful pump could not raise it to the height of forty feet; to admit that insubstantial vapours could form a tube whose sides are capable of resisting the whirling masses of water supposed to ascend through it; to assert that deluges of sea-water are engulphed in the clouds where the clouds cannot retain simple drops of rain, is not in accord with the usage of science, and indeed can only be explained by the dominating power of an old prejudice, which is constantly receiving new life and vigour by the persistent testimony of observers already prepossessed in its favour. There is another reason equally good which accounts for this mode of explaining phenomena. Of all physical inquiries, the most difficult are those which belong to the order of mechanics, which as little admit of sentiment in dealing with them as pure mathematics. In those fields of inquiry where pure mechanics can no longer guide us, the crudest hypotheses take root and grow: witness the wild dreams of the astronomers of the seventeenth century. Now the department of mechanics to which falls the exposition of the gyratory movements of liquids and gases, and on which depend exactly the atmospheric phenomena we speak of, does not yet exist, except as a first and most imperfect draft.

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[*] Continued from p. 459.

[†] It not being considered as disputed that a tornado is nothing but a large waterspout, a typhoon only a large tornado, and that there is no essential difference between a cyclone and a typhoon, M. Faye proceeds to test the theory of centripetal aspiration as regards waterspouts and tornadoes, and conceives that the conclusions thus arrived at will have equal weight when applied to the theory of cyclones.

Taken thus at unawares, as it were, and compelled to rely on evidence altogether illusory and suggesting unhesitatingly the idea of aspiration on a vast scale, modern meteorology strives at least to free itself from conflicting impossibilities. Thus, instead of making the waterspout suck up water in its ordinary form, it is assumed that this water is first blown into spray by the conflict of the winds at the base of the waterspout, and then whirled aloft in this form. A curious experiment was even made in 1852 at Washington, for the purpose of showing that this is the case. The following account of it is taken from the "Fourth Meteorological Report to the Senate of the United States," by Prof. Espy:—

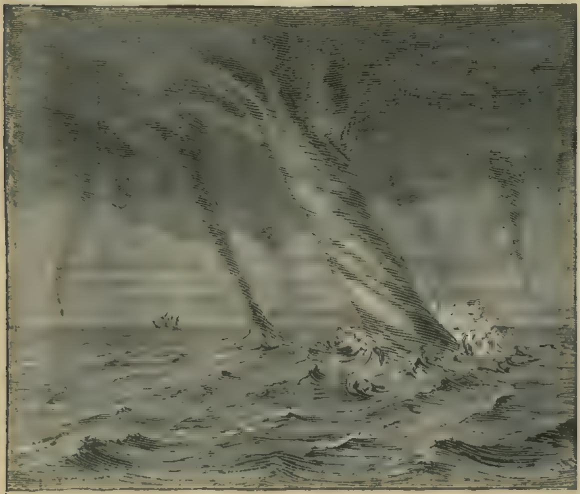

FIG. 6.

'The effect produced by the ascent of a column of air in a narrow space may be thus shown:—If we produce a simple rarefaction of two or three inches of mercury in the upper part of a vertical tube a few feet in length and five inches in diameter, by putting it in connection with the central opening of a machine in full blast, the air will rush into the tube by the lower orifice with a speed proportional to the square root of the diminution of pressure, or about 240 feet per second for an inch of mercury. Then, if a basin filled with water is placed under the opening of the tube and the surface of the water be brought to about 2½ inches from the end of the tube, the water in the basin will be quickly sucked up and ascend the tube, and produce in miniature what takes place in a waterspout. If the tube is glass and of the same dimensions, the water will be seen rising in spray in the form of an inverted cone. This experiment was made in a foundry at Washington in the spring of 1852, in the presence of Prof. Henry and several distinguished members of Congress."

It is singular that none of those present at this experiment remarked the difference there is between a tube of metal or of glass and an almost ideal tube whose bounding surface is only thin insubstantial vapour. The experiment is, however, a proof of the resoluteness with which, in this age even, a belief in the powerful upward suction of waterspouts is entertained.

In order that an ascending current may take place in the atmosphere for some seconds, it is essential that a mass of a lower stratum of air be heated a little more than the air surrounding it. It thus becomes lighter than the layers above it, and consequently rises. In ascending, however, it expands and cools, and soon all further ascent is arrested at a height where the pressure and temperature equal the pressure and temperature of the ascending mass. It is, moreover, replaced from below by air of a lower temperature from all sides. Up to this point there is little, if any, resemblance to a waterspout; there is, however, already the beginning of a movement of ascension, and by means of some new additional hypotheses the phenomenon is completed by giving to it the essential characteristics of a real waterspout.

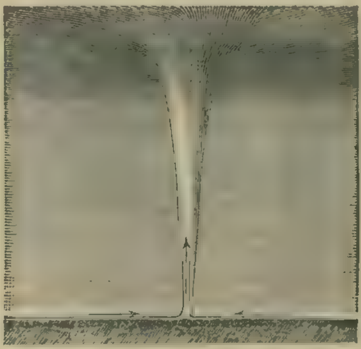

FIG. 7.

Moist air ascends, it is affirmed, more quickly and to a greater height than dry air. Prof. Espy maintains even that it will rise till the limits of the atmosphere be reached in this way:—Moist air in ascending expands and becomes colder; a portion of its aqueous vapour is condensed into mist, and the heat set free in the act of condensation maintains the mass of ascending air constantly at a higher temperature than the stratum of air through which it is ascending. Some physicists consider that these views, thus pushed to exaggeration, are erroneous, but the belief is pretty general, that "the heat due to the condensation" of aqueous vapour is sufficient to raise an ascending column of moist air to a much greater height than an equal column of dry air. Be that as it may, the result would be that when the layers of air resting on the ground are heated by the noonday sun and by radiation, and above all by contact with the ground itself, the equilibrium of the air is disturbed; we should see constantly appearing everywhere a stratum of mist obscuring the rays of the sun. It is useless to point out that this does not represent what takes place. We accept it, however, and proceed.

If we advert to the phenomena of mirage, we find there combined, according to the writers whose theory we are expounding, all the conditions which favour the production of a permanent local indraught of air, and consequently the essential conditions of the waterspout. When the air is perfectly calm and the soil highly heated, the lowest strata of the air are highly heated and thus become specifically lighter than the strata resting over them. But as this excess of temperature is felt at the same time over a wide area, the lower stratum of air rises bodily, so to speak, over the whole region. Now there is no reason why the air should begin to ascend at one place rather than another in the region where the air is perfectly calm; there will be then between the lowest aërial stratum and the one immediately above it a sort of equilibrium, but an equilibrium so essentially unstable that the slightest accident, such as the striking of a light or the flight of a bird, instantly destroys it. As soon as the charm is broken at some point the lower air will there ascend, and as it is charged with moisture it will continue to rise in an ascending column to the higher regions of the atmosphere. In rising, this air will leave a vacuum below it, towards which will rush the air of a lower stratum. This will in turn follow the first in its ascent, and it is seen that gradually the air of this highly heated lower stratum will flow from all sides with an accelerating speed *towards the pathway opened by the first ascending puff of wind*. As this propagation of the horizontal movement extends wider and wider over the heated stratum, the air which arrives at the place where ascending currents have set in will be of the temperature required to keep up the indraught. Further, the *vis viva* of the air currents about the narrow space where the equilibrium was first disturbed will acquire a force capable of producing, a short distance from the point towards which they all converge, very considerable mechanical effects. Then, if the whirlwind advances on the sea, its surface, lashed on all hands by the converging winds, is thrown into a state of ebullition; the spray is drawn up in an ascending column and whirled aloft, however slight may be the spiral form assumed by the horizontal converging currents. The air which rises so violently in the waterspout will be thrust higher and higher, as we have just seen, by the force constantly called into play by the condensation of the vapour into cloud and rain; at length it reaches the high regions of the atmosphere, where it expands and swells into a dense cloud of enormous dimensions. This, then, is the theory of aspiration.

Before a physicist reasons in this way he ought to be well assured beforehand that the facts are as he supposes; in other words, that waterspouts suck up by a vast upright tube the air and the water of the lower strata. Otherwise he would not fail to remark that if the equilibrium, eminently unstable, which he assumes to be established, comes to be destroyed at any point, it would be quickly destroyed over the whole extent of the lower stratum, the different parts of which would then rise freely, each in its place successively, over the small space required for the re-establishment of the equilibrium of the atmosphere. If, in support of any other theory, a similar mechanical combination were proposed to him, he would reject it without hesitation, and say—in order that such phenomena can take place, in order that the lower air should flow horizontally towards a particular orifice and then rise vertically through this orifice, it would require to be forced to do so by some sort of indefinite but solid boarding placed over the lower stratum of air and pressing on it with all the weight of the atmosphere. If a hole be made in the boarding, the air will pass through it; but even in this case, its ascensional force determined by the slight difference in density between the layers on each side of the boarding will not be great, and the column of air issuing through the orifice will rise to no great height. In no conceivable case can it ever exhibit the terrible and destructive force of waterspouts and whirlwinds, or indeed any distant approach to it, under even the most favourable conditions. Lastly, let it be granted that the facts really are as they are supposed to be, and that the lower stratum of air is on every side in a state of motion towards an orifice of a limited size, where there is no material object to divert it from a horizontal to a vertical course, as in Fig. 7; it is plain that aërial currents could not change their course so abruptly in order to stream through this imaginary orifice; they would instantly enlarge and soon altogether efface from the sky the narrow tube of this meteor to which the advocate of aspiration clings because it is the *sine quâ non* of his cherished hypothesis.

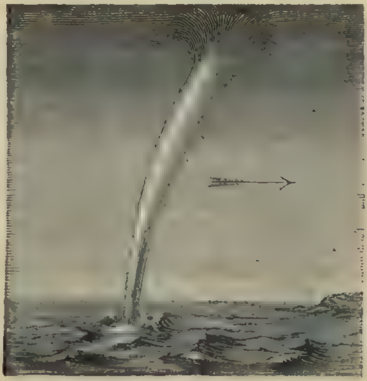

FIG. 8

But we shall pass over all these impossibilities which prejudice so readily forgets, and consider the consequences which result from this theory—not those which might be drawn to show its utter worthlessness, but those which its own partisans have deduced. It is so easy, from what has been said, to produce a waterspout at will, and everything connected with it—large dense clouds aloft with thunder and torrents of rain—that the idea could not but strike some one. Accordingly, it occurred to several persons in America, where the theory of aspiration has been received as favourably as in France, and the artificial production of a waterspout and a thunderstorm in the United States is gravely related in a letter from Mr. G. Mackay, which letter is published in the "Fourth Meteorological Report to the Senate" (Washington, 1857.) It would be a waste of time to make any further reference to an illusion which puts into man's hands the power of originating waterspouts, tornadoes, and typhoons, simply because it makes the phenomena depend on a state of unstable equilibrium in those layers of the atmosphere which immediately surround us.

Refutation of this Theory.—Let aspiration be established by natural or artificial means at one point in the midst of an absolute calm prevailing in the lower stratum of the atmosphere: there is no reason in such a case why the centre of aspiration should be displaced, because all is symmetrical and tranquil round this point. Hence it follows:—(1) Waterspouts, tornadoes, typhoons, and cyclones should be stationary. At most the column of

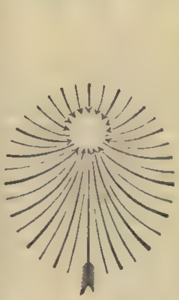

FIG. 9.

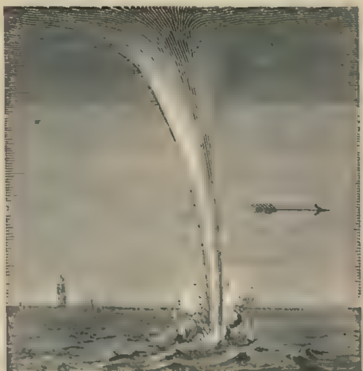

FIG. 10.

ascending air, when it has reached the elevated regions of the clouds, could not be diverted above by upper currents so as to assume the form represented in Fig. 8; for these upper currents could no more displace the focus of aspiration than they could move a locomotive by deflecting the column of smoke which issues from it. (2) The mechanical effects will be very limited, because the aspiring force being measured by a few millimetres of mercury, were the end of the suction-tube to be plunged into a river or the sea, the water would be raised there a few centimetres. Moreover, at the instant when the extremity of the tube reaches the ground or the water, the air ceases to flow into it and fails any longer to keep the ascending column together, and thus all mechanical action ought to disappear at this moment. Further, it is evident that if the phenomenon has its origin in a perfectly calm stratum of air where not a breath of air is felt, the element of mechanical work, that is to say the force or the motion, fails altogether, or becomes reduced to a feeble ascensional tendency in any stratum of air that may have acquired over the place an abnormal excess of a few degrees of temperature.

Compare now with the facts, these two conclusions drawn from the theory. It would be difficult to find a disagreement more complete. Everyone is aware of the ravages produced by hurricanes, typhoons, tornadoes, and even simple waterspouts and whirlwinds—ravages which imply an enormous development of mechanical force. Then, everyone knows that the peculiarity of all cyclones is to possess a movement of translation, often very rapid, which the theory of centripetal aspiration denies to them. Of all waterspouts hitherto observed, only one instance of a stationary one has been recorded; and even the stationary character in this exceptional case may have been not real but only apparent. As regards tornadoes, all those that traversed the United States since 1811 were propagated onwards with a speed varying from four or five to twenty metres a second. The well-known waterspout of Monville, in France, swept over a league in less than four minutes, or at a rate of about twenty metres per second. At such rates typhoons and cyclones, without exception, also advance; their movement of translation is usually increased as they proceed into higher latitudes, and varies from three to eighteen nautical miles an hour, or from two to ten metres per second.

It has been said by the advocates of the theory of aspiration as applied to hurricanes, that if the converging currents are stronger on one side than on the other, the centre of aspiration, that is the base of the waterspout, will be displaced in the direction indicated by the stronger currents, as shown in Fig. 9. But why this difference of speed, especially over the sea, where there are no inequalities of surface over which the different winds blow? The velocity with which air free to move rushes into a suction-tube is determined by the amount of the suction force; if the movement be impeded on one side of the orifice, the air will enter by the other with a determined velocity, but not with a velocity tripled or quadrupled. Moreover, in order that an excess of velocity of twenty metres per second on one side of the centripetally flowing currents could communicate a like velocity to the onward march of the waterspout, it would be necessary that a wind of the force of a terrible tempest blew in that direction exceeding by a velocity of twenty metres per second the contrary wind. This is scarcely compatible with the absolute calm which ordinarily prevails round waterspouts, tornadoes, and even typhoons.

Fig. 10 represents the appearance of a waterspout whose base is represented as driven forward by a supposed excess of velocity of the inflowing horizontal currents, whilst the top of the ascending column is retarded by the resistance of the air. Now the real figure is that represented in Fig. 11, and it agrees neither with Fig. 9 nor with Fig. 10.

It will be seen on reflection that under all these attempts at explanation there lies a settled conviction which Pliny has aptly expressed in these words: "Quum spissatus humor rigens ipse se sustinet,"—the idea, in fact, which was naïvely reproduced in the experiment at the foundry at Washington, in which it was tacitly assumed that the column of a waterspout or tornado is composed of some rigid material, and that it may be displaced bodily by a force acting on its lower part. In truth, the force which could so act is not to be found. The explanation suggested by Prof. Mohn, that the movement of translation of storms is determined by a difference in the average pressure in the front as compared with the rear of the storm, caused by the condensation of vapour which takes place in front, is insufficient, because we see waterspouts and tornadoes marching onwards, from which not a single drop of rain falls.

No navigator has ever shown that there is in a cyclone the least indication of a decided movement of ascension to which the essential cause of the phenomenon is attributed. Everyone speaks about ascending currents, but no one has seen them, or seems even to have had the idea of verifying their existence in the case of their assumed hurricanes of aspiration. The whole thing is taken for granted, and preconceived notions, whose origin we have traced, have complete control over their thoughts.

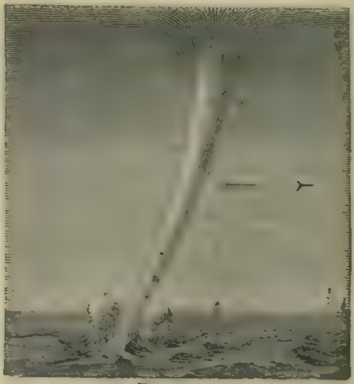

FIG. 11.

As regards waterspouts, no manner of doubt is entertained, for the water is seen whirled up their columns skywards. If this were really the case, waterspouts and tornadoes might draw up even to the sky the thousands of trees which they uproot, and a little afterwards furnish the spectacle of a whole forest tumbling from the clouds, it being evident that thousands of trees may be transported as easily to the clouds as thousands of tons of sea-water. Eye-witnesses are not wanting to prove that branches of trees have ascended beyond the clouds, they having been seen lying at some distance on the ground, covered with hoar-frost in the middle of summer.

What remains then of the theory of hurricanes which is based on centripetal aspiration? It starts from a prejudice, sacrifices at the outset the simplest notions of mechanics, and does not take the trouble to represent a single characteristic trait of the phenomenon. Is it then on this theory we are to rely for the rectification and completion of the laws of storms? Shall we borrow from it, in order to correct the diagrams of Reid and Piddington which are perhaps in some cases too absolutely circular, the hypothesis of centripetal currents suggested by it. Especially shall we sacrifice to it the practical rules of navigation followed during the past thirty years? Unhappily there is some cause for fear, for sailors themselves have long since been prepared by the tales and narrations of the forecastle, for these ideas of aspiration affirmed regarding tornadoes, typhoons, and cyclones. If then they are told that in a particular case one of the laws of storms has suffered an exception, that the wind has on one occasion not blown perpendicularly to the direction of the centre, they will be tempted to cast aside the rules which have hitherto guided them. This would only be to sacrifice reality to an empty illusion, and science to error.

It is for this reason that we have insisted at some length on a prejudice which might result in consequences so deplorable. But half of our task is still before us. We have yet to point out the true theory of these phenomena, and to show how the sailing rules hitherto adopted are justified by it. In this way will these rules, thus cleared from empiricism, be invested with the authority which they at present stand in need of.

(*To be continued.*)

NOTES

THE following are some of the principal works in the various departments of science and in travel which are announced for publication during the present season. Messrs. Longman and Co. have the following in preparation:—"The Moon and the Condition and Configurations of its Surface," by Edmund Neison, F.R.A.S., illustrated with maps and plates. "An Epitome of the Geology of England and Wales," by Horace B. Woodward, F.G.S., Geologist on the Geological Survey of England and Wales; and a new volume of the "Text-Books of Science," "Telegraphy," by W. H. Preece, C.E., and J. Sivewright, M.A. "Shooting and Climbing in the Tyrol," with an account of the manners and customs of the Tyrolese, by W. A. B. Grohmann, with numerous illustrations from sketches by the author. "The Frosty Caucasus, an account of a walk through part of the Range and of an ascent of Elburz in the summer of 1874, by F. C. Grove, with map, and illustrations engraved on wood by E. Whymper, from photographs taken during the journey. "The Indian Alps and how we crossed them," being a narrative of two years' residence in the Eastern Himalayas, and two months' tour into the interior towards Kinchinjunga and Mount Everest, by a Lady Pioneer. This work will contain a large number of wood engravings and twelve full-page chromolithographs. "A Journey of a Thousand Miles through Egypt and Nubia to the Second Cataract of the Nile," being a personal narrative of four-and-a-half months' life in a Dahabeeyah on the Nile; with some account of the discovery and excavation of a rock-cut chamber or Speos at Aboo-Simbel; descriptions of the river, the ruins, and the desert, the people met, the places visited, the ways and manners of the natives, &c., by Amelia Edwards, author of "Untrodden Peaks and Unfrequented Valleys," &c. The work will also contain ground plans, facsimiles of inscriptions, a map of the Nile from Alexandria to Dongola, and about seventy illustrations engraved on wood from finished drawings executed on the spot by the author.—Messrs. Sampson Low and Co. have nearly ready for publication Mr. John Forrest's "Explorations in Australia." The work will include three different journeys, namely: (1) Expedition in search of Dr. Leichardt and his party; (2) A journey from Perth to Adelaide, around the Great Australian Bight; (3) From Champion Bay across the desert to the Telegraph and to Adelaide. The book will contain illustrations from the author's sketches. Messrs. Longman have also in the press the following:—A work by Dr. Arthur Leared, on "Morocco and the Moors," being an account of travels, with a general description of the country and its people, with illustrations. A new volume on Assyria, by Mr. George Smith, entitled "Assyrian Discoveries," containing the Chaldean accounts of the Creation, the temptation and fall of man, the Deluge, the Tower of Babel and Confusion of Tongues, Nimrod, &c. This book will be profusely illustrated. A translation of Herr Edouard Mohr's "Nach den Victoriafällen des Zambesi" (reviewed in NATURE, vol xii. p. 231), containing an account of the South African Diamond Fields, &c., is also promised; it will be accompanied by numerous full-page and other woodcut illustrations, several chromolithographs, and a map.—Messrs. Daldy, Isbister, and Co. have in the press a "Geology for Students and General Readers," embodying the most recent theories and discoveries, by A. H. Green, Professor of Geology and Mining in the Yorkshire College of Science. It will be divided into two parts, the first containing the elements of Physical Geology; and the second, the elements of Stratigraphical Geology. Each part will contain upwards of 100 illustrations by the author.—Messrs. Macmillan and Co. have in preparation for the ensuing season, "A Course of Practical Instruction in Elementary Biology," by Prof. Huxley, F.R.S., and H. N. Martin, B.A. "The Modern Telescope," by J. Norman Lockyer, F.R.S.; lectures delivered at the Royal Institution, with additions by G. M. Seabroke, F.R.A.S. This work will be copiously illustrated, and will be uniform with the author's "Solar Physics." Also a work on "Stethometry: Examination of the Chest by a new and more exact method;" with some of its results in physiology and practical medicine, by A. Ransome, M.D. The two following books of travel will also be published in the autumn by Messrs. Macmillan and Co.:—"The Two Expeditions to Western Yunnan, commanded by Major Sladen and Col. Horace Browne," by Dr. Anderson, Director of the Indian Museum, Calcutta, and Professor of Comparative Anatomy in the Medical College, Calcutta, with numerous maps and illustrations. "The Zoology and Geology of Persia," by W. T. Blanford, with narratives of travel by Majors Lovett, St. John, and Evan Smith, and an introduction by Sir Frederick Goldsmid. This work will contain coloured plates and maps, and will be issued in two octavo volumes.—Among Messrs. Smith, Elder, and Co.'s announcements of forthcoming books we notice the following which may be of interest to our readers:—"Science Byways," by Richard A. Procter; and "Notes on the Climate of the Earth, Past and Present," by Capt. R. A. Sergeaunt, Royal Engineers. This last work will be illustrated with diagrams.

THE Yorkshire College of Science at Leeds, which was informally opened a year ago, was formally "inaugurated" yesterday by the Duke of Devonshire and other eminent men. There was a luncheon in the Great Northern Hotel, and a public meeting in the evening, addressed by the Right Hon. Lyon Playfair and others. The first session of this College, it is said, was as successful as could be expected. We have already stated that we cannot regard this institution on its present basis as satisfactory. Except for students whose education up to a certain point has been complete, the curriculum of a science faculty by itself, however complete, may easily do more good than harm. What we want are not separate science colleges, but first-rate secondary schools in which science should find its proper place. When these secondary schools exist, then the students who have passed through them may benefit from a technical school in which no literature is taught—but not till then.

THE inaugural sitting of the International Geodesical Congress took place on the 20th September at the Ministry of Foreign Affairs, Paris, under the presidency of General Hanez, the delegate for Spain. No delegate was present for Great Britain or for the United States; the German Empire was represented by General de Bayer, the Russian Empire by General de Broch, the Austrian Empire by Dr. Oppolzer; Italy, Belgium, Roumania, Switzerland, and the several German States were also represented. M. Charles Jourdain, member of the French Institute, and general secretary of the Minister of Public Instruction, delivered a speech in the name of M. Wallon, who is travelling in the provinces. It was replied to by General Hanez and by General de Bayer. M. Faye spoke in the name of the French section, which had invited a number of eminent men of science to take part in the proceedings. A number of reports of the Permanent Section having been read, the assembly adjourned to the following day. On the following evening a number of the delegates visited the Observatory of Paris. It is stated that the longitude of Palermo and Lisbon will be determined electrically with the instruments which have been used for determining the longitudes of Vienna and Algiers.

A PAIR of Sea Lions are shortly expected at the Brighton Aquarium, from the coast of California. They most probably are specimens of Steller's Sea Lion (*Otaria stelleri*), or of Gilliespie's Sea Lion (*O. japonica*), judging from the locality whence they were obtained. It must be remembered that the name Sea Lion corresponds with the genus scientifically known as *Otaria*, and that there are several species, two of which—*O. jubata* and *O. pusilla*, both from the Falkland Islands—are represented in the collection of the Zoological Society in Regent's Park. Further information with reference to these interesting animals, from some species of which the so-called sealskin of commerce is obtained, will be found in our abstracts of two lectures delivered in the Zoological Gardens by Mr. J. W. Clarke during the early summer of this year (NATURE, vol. xi. p. 514, and vol. xii. p. 8).

THE organisation of the French meteorological regions is progressing satisfactorily. The example was set by Montpellier for the southern Mediterranean region. The northern Mediterranean region has now been centralised at Marseilles, and will very shortly commence operations. A special Meteorological Congress will be held in Poitiers for the western and south-western regions. The date is not quite determined, but a day in the end of October will probably be chosen."

A NEW Physical Observatory is to be erected at Pawlowsk, in connection with the Imperial Russian Physical Observatory at St. Petersburg.

MR. W. B. HEMSLEY has been appointed librarian to the Lindley Library, at the rooms of the Royal Horticultural Society, South Kensington, in the place of Prof. Thiselton Dyer.

THE Astronomical School established at Montsouris under the authority of the French Bureau des Longitudes was opened on Monday morning at eight o'clock by Capt. Mouchez, the director, and Admiral Paris. The pupils are six in number, all of them being lieutenants in the national navy. The period of study is six months. Every two months two pupils will leave and be replaced by two other naval lieutenants. A number of sailors will be attached to the establishment. The students will be taught the practice of celestial photography, spectroscopy, meridian observations, &c.

WE noticed the establishment of a School of Anthropology as being in preparation in Paris some months ago. We are in a position now to give the complete list of professors and the subjects for the course of lectures:—Broca, anatomical anthropology; Dally, ethnological anthropology; De Mortillet, prehistoric anthropology; Hovelaeque, linguistic anthropology; Topinard, general anthropology; Bertillon, statistical and geographical anthropology. MM. Broca, Dally, and Bertillon are connected with the press, and leading members of the Paris Anthropological Society; M. de Mortillet is the Conservator of the Prehistoric Museum at St. Germains.

A MERIDIAN-ROOM, intended for the observations of the French Bureau des Longitudes, was opened last Saturday by M. Dumesnil. The Bureau is now an independent establishment, having an office for meetings of members and computers in a pavilion belonging to the National Institute.

IT is proposed to hold an Electrical Exhibition in Paris in 1877. It will be held in the Palais de l'Industrie, the object being to illustrate all the applications of electricity to the arts, to industry, and to domestic purposes. This project, which was initiated by Count Hallez d'Arros, has been received with general favour both by the scientific and industrial worlds, and the necessary funds have been already guaranteed. An organising committee is being formed, and the provisional offices of the Exhibition have been established at 86, Rue de la Victoire.

THERE has been recently published in Russia a work by MM. Mendeléef and Kirpetschoff, on the Compressibility of Gases. The authors have been led to several results which ought to attract the attention of physicists; they tend, in fact, to prove that Mariotte's Law does not hold good at low pressures, and that some of the results of Regnault's experiments do not agree with those obtained in other conditions.

THE Swedish Arctic Exhibition arrived at Hammerfest on Sept. 26, in perfect health and condition. They have brought back a rich naturalist collection and several important hydrographic reports. The mouth of the Jenisei river was reached on the 15th of August, and Professors Nordenskjöld, Sundstroem, and Stuxberg took leave of the expedition four days afterwards. They will return to Sweden *viâ* Siberia.

THE following pretty optical experiment is sent us by Prof. F. E. Nipher. Observe a white cloud through a plate of red glass with one eye, and through green glass with the other eye. After some moments transfer both eyes to the red glass, opening and closing each eye alternately. The strengthening of the red colour in the eye, fatigued by its complementary green, is very striking. The explanation of the phenomenon is of course well known, and many modifications of the experiment will readily suggest themselves.

IT is known to many experimenters that pulverised magnetic oxide of iron is to be preferred to iron filings in making magnetic curves. It is easily pulverised to any desired fineness. We do not know why filings are so universally recommended by writers on this subject.

THE Botanical Society of France has been recognised as an establishment of public utility by a presidential decree of Aug. 26. French botany has recently sustained a great loss in the death (at the age of seventy-two years) of M. Boreau, director of the Botanic Garden of Angers. M. Boreau was the author of a "Flora of Central France and of the Basin of the Loire," a work which has reached its third edition. Many papers by him have appeared in the *Memoirs* of the Société Académique de Maine-et-Loire.

AT the International Medical Congress at Brussels, Prof. Marey gave before a large and interested audience a simple, clear, and very complete account of the principal advances in physiology which are due to the introduction of the graphic method into its means of investigation. The application of the methods of mechanics and physics, he believes, has shown what vast horizons are open to the researches of the physiologist, by proving that now we may calculate exactly infinitely small quantities in space and time.

THE August part, just published, of the *Bulletin* of the French Geographical Society contains a very curious and interesting paper by M. E. Cortambert, on "the geographical distribution of celebrated persons in France, or the density of the intellectual forces in various parts of France." It is intended to accompany a map in which, by various tints of colour, it is attempted to indicate the proportion of notable men which have been born in the various departments of the country. M. Cortambert goes rapidly over the various regions and departments, indicates the relative proportion of notable men belonging to each, and the particular intellectual product in which each has been most fertile. As might be expected, the north, particularly the basin of the Seine, which includes Paris, the great centre of population, is the richest. Seine-et-Oise, l'Aisne, Seine-Inférieure, Calvados, Champagne, are also marked by a deep tint. In the east, Alsace and Lorraine—which in this respect may yet be considered French—Burgundy, especially the Côte d'Or, Doubs, Lyonnais, and French-speaking Switzerland, all stand out prominent. In the south, Isère, Bouches-du-Rhône, Hérault, Haute-Garonne, Gironde, are the most remarkable. The west, as a whole, is but slightly tinted, notable exceptions being Ille-et-Villaine, Charente-Inférieure, and to some extent Maine-et-Loire and Finistère. In general, however, Brittany, whose inhabitants have many other noble qualities, does not show any great eminence from an intellectual point of view. This M. Cortambert is inclined to attribute to the fact that the Bretons are still to a large extent Celtic; and it is noteworthy that the centre of France, where also the same element is still strong, is also comparatively poor in eminent intellectual products. With regard to the particular kind of intellectual product for which each district is noted, M. Cortambert finds that the north is specially fertile in poets, claiming such names as Malherbe, Corneille, Racine, Molière, Boileau, La Fontaine, Voltaire, Beranger, De Musset; while in science it has produced such names as La Place, Élie de Beaumont, Delambre, Ducange; also not a few men eminent as painters, warriors, musicians, historians, and a large proportion of geographers. From the east come many men who have a world-wide fame in the natural, physical, and medical sciences—Buffon, Cuvier, Daubenton, Berthollet, André Ampère, Jussieu, Bichat, Récamier, Saussure, Bonnet, De Candolle, Agassiz, and others; in other departments also, specially in literature and art, this region has been fertile in great names. The south stands out prominent in the region of orators, but has also produced such men as Fermat, Legendre, Arago, Borda, Montesquieu, Montaigne, Tournefort, and Adanson: Brave sailors and celebrated voyagers are the special product of the west. In Brittany and the Centre, philosophy seems to dominate; to the latter belong Pascal and Descartes, and the daring humourist Rabelais. Altogether M. Cortambert's researches in this direction are of special interest, and will be of real value if he connects the results above indicated, as he states he intends to, with the nature of the physical and ethnographical characteristics of the various regions which he has surveyed.

WE read in the Lille papers that the Catholic University of that town has been granted the use of Saint Eugenie Hospital. under certain restrictions.

THE *Geological Magazine* states that Dr. W. Waagen has been appointed to the post of Palæontologist to the Indian Survey rendered vacant by the death of Dr. Stoliczka.

SCIENTIFIC work will soon be resumed in Paris with activity, the Geographical, Biological, Anthropological, and other societies recommencing work within a few days. The Institute is the only French scientific institution which takes no holiday, even for any religious solemnity or national festivity. The regular weekly meetings were only interrupted *once* during the Commune, when civil war was raging in Paris. M. Élie de Beaumont, who was the perpetual secretary, tried to reach the Institute in order to open the sitting, but he was prevented by insurgents refusing to allow him to cross the barricades.

WE have now the final fasciculi of a work, the publication of which has extended over the last five years, the "Nomenclator Botanicus," by Dr. L. Pfeiffer, of Cassel. In two volumes, amounting to over 3,500 pages, are here enumerated all the names and synonyms which have been applied to classes, orders, tribes, families, divisions, genera, and sub-genera of plants, from the time of Linnæus or earlier to the end of the year 1858, with reference to the place of publication. The work will be indispensable to anyone compiling a monograph of a genus or order. It is intended shortly to continue the work down to the most recent times.

THE intended publication is announced, by subscription, of a "Flora of Clackmannan," by Messrs. James R. and T. Drummond. Subscribers' names are to be sent to Messrs. Maclachlan and Stewart, Edinburgh.

THE Report of the Curators of the Botanical Exchange Club (Dr. J. T. Boswell and Mr. J. F. Duthie) for the last two years has just been published. It gives the new localities for scarce plants discovered during that time, and describes in great detail the observations which have been made on new forms or varieties of British plants.

THE *Photographic News*, in speaking of "Photography and the Illustrated Press," gives some examples of the extent to which the latter is now dependent on the photographic art. The *New York Daily Graphic*, besides often executing its pictures from photographs, employs a photo-mechanical process in the production of some of its work. At the office of the *Moniteur Universel*, which is one of the most extensive printing and publishing establishments in France, arrangements are being made for large photo-printing works, as well as for producing coloured pictures by M. Leon Vidal's photo-chromic process. In this country photography is used to aid the artist in sketching to a great extent. One of these days, no doubt, the *News* believes, we shall have our papers illustrated by photographs *pur et simple*, but even now photography has far more to do with the execution of the illustrations in our journals than most people may be aware of.

"WE were witness,' says the *Photographic News*, "the other day of a very pretty application of light made by a gardener. Everybody knows that the ripening and colouring of fruit are due for the most part to light and heat, and that the roses upon an apple are influenced by the manner in which the sun strikes it. On looking at some fine wall-fruit in a Kentish garden, the proprietor called our attention to the manner in which he allowed his peaches to be partially covered by a leaf or two, in places—namely, where he wished them to remain green—and thus heighten by contrast the purple bloom on other portions of the fruit. There were many examples of a leaf being very sharply photographed upon the fruit, and the grower, by exercising a little care during the ripening season, thus enhanced the beauty of his fruit, and also their value, as in the case of a peach it is not only its flavour, but its appearance, which governs the price at Covent Garden."

A CORRESPONDENT writes as follows to the *Derry Sentinel*:—"On Sunday evening last, while going into the country, I observed at Churchill, Glendermott, a bird which at first sight I could not easily class among any known species. On coming closer, however, I found that it was a white swallow. There was no perceptible difference between it and the common swallow, with the exception of its plumage being of the purest white. Other swallows were flying about at the same time, but this *rara avis* shunned their company, and did not seem anxious to join them, as it flitted about by its solitary self, and kept at a respectful distance from the others. As I have never heard of a white swallow having been seen about this part of the country before, I consider it to be a very strange visitor."

PROF. E. MORREN, of Brussels, has been making some experiments with insectivorous plants, with the result that he combats the view that they possess the power of absorbing and assimilating animal matter, as stated by many observers in this and other countries. He says that so far as *Pinguicula longifolia* and *Drosera rotundifolia* are concerned, at least, he believes that the glutinous excretions of their leaves simply hasten decomposition, which is moreover attended by the usual concomitant phenomena. In very early stages he found monads, bacteria, the mycelium of various fungi, and other conditions of putrefaction. So far as the action of the mucus on the entrapped insects and on coagulated albumen is concerned, he affirms that it is similar to that of pure water, sugar-water, and the honey-secretions taken from the flowers of *Aechmea nudiflora*. Nevertheless he admits having seen all the admirable contrivances for catching and retaining insects.

MR. G. M. DAWSON, F.G.S., has just issued a report to the Canadian Government, on the geology and resources of the region in the forty-ninth parallel, between the Lake of the Woods, S.E. of Lake Winnipeg, and the Rocky Mountains; in other words, of the western portion of the boundary of British America. Much of the country traversed had been previously quite unknown, geographically as well as geologically, which fact adds greatly to the importance of the report, the bulk of which is devoted to the account of the Cretaceous and Tertiary strata of the plains between the Rocky Mountains, as they are constituted at the boundary, and the Lake of the Woods. The Survey of the United States Government to the south of the above-mentioned region, when taken in conjunction with that under notice, forms a vast addition to geologic knowledge. Among the most important results arrived at is the discovery of beds which seem to gap over the apparently considerable interval between the Cretaceous and lower Tertiary periods.

THE following interesting statistics on the libraries of Europe are taken from M. Block's recently published "Statistique de la France comparée avec les divers pays de l'Europe":—Paris has six great libraries belonging to the State and open to the public. Outside Paris there are in France 338 libraries which possess more than 3½ million volumes; of this number 41 are open in the evening. Great Britain possesses 1,771,493 volumes, or six vols. to each 100 persons of the population (this must surely refer solely to the British Museum library). Italy has 11·7 volumes per 100 inhabitants. In France there are 4,389,000 volumes, or 11·7 per 100 persons; in Austria, 2,488,000 vols. or 6·9 per 100; in Russia, 852,000 vols., or 1·3 per 100; in Belgium, 509,100 vols., or 10·4 per 100. Of all countries, France possesses the greatest number of volumes, and Paris alone has one-third of them in its libraries. Since 1865 students' libraries have been formed over nearly the whole of France. Since that year these libraries have increased from 4,833, containing 180,854 volumes, to (in 1870–1) 13,638, containing 1,158,742 volumes.

THE additions to the Zoological Society's Gardens during the past week include four Tigers (*Felis tigris*) from India, presented by H.E. the Governor-General of India; an Ocelot (*Felis pardalis*) from South America, presented by Mr. H. Kirtley; a Golden Agouti (*Dasyprocta aguti*) from South America, presented by Mr. Henry T. Balfour; a Cuvier's Toucan (*Ramphastos cuvieri*) from Upper Amazons, presented by Mr. A. Blumenthal; a Chilian Sea Eagle (*Geranoaëtus aguia*) from Paraguay, presented by Mr. E. Nelson; two Red and Yellow Macaws (*Ara chloroptera*) from South America, presented by the Misses Rix; three Tigers (*Felis tigris*), a Leopard (*Felis pardus*), a Caracal (*Felis caracal*), two Musanga Paradoxures (*Paradoxurus musanga*) from India, a Black Lemur (*Lemur macaco*) from Madagascar, a Crab-eating Opossum (*Didelphys cancrivora*) from Central America, two Mexican Deer (*Cervus mexicanus*), deposited; a Great-billed Parrakeet (*Tanygnathus megalorhynchus*) from Gilolo, received in exchange; an American Darter (*Plotus anhinga*) from South America, purchased.

SOME LECTURE NOTES ON METEORITES*

II.

WE may next turn our attention to the nature of the substances which fall on these occasions, and in the first place it may be briefly stated that they are of three kinds: first, masses of iron, alloyed with nickel, termed aërosiderites, or briefly siderites; secondly, stony meteorites (aërolites), which consist of silicates somewhat analogous to terrestrial rocks, but having nickeliferous iron disseminated in small granules throughout them: and finally, there is a sort of meteorite which is intermediate between these iron and stone masses, consisting of a sponge-like mass of the iron, containing in its hollows stony matter similar to that of the aërolites. These are what are termed siderolites (or meso-siderites). These different kinds of meteorites—namely, siderites, siderolites, and aërolites—then, comprehend all the forms of matter, as at present known, which fall to the earth from the regions external to its atmosphere.

Of these different kinds of meteorites, national as well as private collections have been formed in most countries in Europe. The most celebrated and historical collection of them is that at Vienna, formed by the gradual and generally contemporary acquisition of specimens of the meteorites as they have fallen or been found from time to time, from the early years of this century, and descriptions of them have been given by very eminent Viennese mineralogists. Then we have in the British Museum a not less complete collection, numbering now about 294 different meteorites. Next to these in completeness is the collection at Berlin, founded on that formed by Chladni.

The importance of the study of such collections of meteorites becomes evident, if we consider a remark of Humboldt's, in the latter part of his "Cosmos," to the effect that there are only two avenues to our knowledge of the universe outside of us, one being light, by the agency of which the motions of the heavenly bodies are revealed to us, while the other consists in the masses of matter that come to our earth from that outer universe; and that these are the only means by which we are able to take any cognisance of what is going on in the boundless regions of space.

Since Humboldt's time, indeed, light has become a totally different instrument in our hands to what it was. No longer are the heavens for us without speech or language, for light is indeed the language of the universe, though man has only yesterday begun to interpret the voices whereby one star calleth to another star.

Our interpreter is the prism, that most subtle and sensitive implement for probing the character of the most distant matter provided only it be luminous. In Humboldt's time light merely enabled us to record and calculate the mute motions of the orbs around us. Now not only are we able so to tell their motions, but we may feel new truths "trembling along that far-reaching line" which connects our eye with a star, and take cognisance of the physical conditions and chemical composition of the matter in active change upon the surface of that star. And this altogether new source of knowledge throws an entirely new interest around the question of the origin or sources of meteoric matter. Let us then next inquire of the meteorites themselves what they have to tell us in elucidation of these questions.

The first aspect of a meteorite is that of a fragment. One cannot look at it without saying so. But as to the question whether it came as a fragment into our atmosphere, or whether it became a fragment after it had entered it, we can at least say that its present fragmentary form is mainly due to the action of that atmosphere itself. Still, it is eminently probable, from other grounds, that meteorites encounter our earth, and probably our system, in the guise of fragments, or rather of angular and unshaped masses—chips, as it were, thrown off in the great workshop; matter flung out into space, not yet used up in the making of the worlds. It will be well first to consider what an examination of their physical characters and general internal structure will reveal to us. For the incrustation and pitted surface of aërolites already described an explanation was sought on the hypothesis of external fusion arising from the sudden development of enormous heat on the surface of a mass internally brittle and contracted, owing to its very low temperature. And among the more purely mechanical characteristics, we must not pass over the general want of compactness in meteorites. Thus, though a meteorite generally seems very compact, if it be suspended in chloride of mercury to dissolve the iron without affecting, or with only slight effect on, the other minerals in it, you will dissolve meteoric iron out of it; but the remainder of the mass will, after this treatment, in most cases, crumble into a granular powder, showing that the cohesion of the mass is not like that of an ordinary terrestrial rock. Some aërolites, again, will even crumble in the fingers without previous treatment.

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* Continued from p. 487.

The rocks to which they bear the nearest resemblance, in respect of their mechanical structure, among the products of our volcanoes, are some volcanic bombs, and, as regards several of the aërolites, certain kinds of volcanic tufa.

Now, in examining these bodies more closely, the first thing that calls for attention is that they are composed entirely, or almost entirely, of crystalline substances; and that matter thus coming from regions beyond our world crystallises in the same way, and is obedient to the same law, as matter which crystallises on the globe.

Sections of meteorites cut thin and ground down to transparent slices, when examined by means of polarised light, are seen to be crystallised throughout; the crystalline character of the substances being evidenced by the interference tints which colour the different crystals of which the sections are made up. Another characteristic of many meteorites, in which they differ from ordinary terrestrial rocks, is what has been termed by Gustav Rose their chondritic structure. The minerals in these are found to be more or less aggregated in little spherules, which are distributed in different degrees of abundance in different meteorites through the ground-mass of the stone.

Sections of chondritic meteorites show them to consist in some cases almost entirely of spherules. Such is the case with the Parnallee aërolite, of which the most varied groups of spherules may be seen assembled in a single section. Some of these spherules are encased, as it were, in minute shells of metallic (nickeliferous) iron, or of such iron mingled with a kind of pyrites peculiar to meteorites, an iron sulphide termed troilite, constituted by an equivalent of sulphur combined with one equivalent of iron. Minute granules of troilite and iron, without any definite form, are so seen to be disseminated among the grains of the interspherular ground-mass of the meteorite.

A closer inspection of the spherules further reveals in many cases the presence of *intra*spherular iron. In some spherules the meteoric silicates may be seen, radiating from a point, but while the spherule is enclosed in a mixed outer mass of silicates, iron and troilite in little black specks are seen scattered all through it, presenting the appearance of having been spurted, as it were, from a point, the larger particles to the greater distance: and these specks consist in part of nickeliferous iron, while some are meteoric pyrites (troilite).

In connection with the subject of these spherules, which form so characteristic a feature of many stony meteorites, it should be mentioned that occasionally some of the spherules are seen to be broken in half and the halves separated from each other to some small distance, a fact of considerable significance, though not easy of interpretation in connection with the history of the meteorite and the more or less violent crises it must have passed through at successive periods in that history.

Evidence of another kind of historical succession in the events and influences through which a meteorite may have passed is afforded by the not rare peculiarity of a sort of vein, like a mineral vein, running through the meteorite. In fact, just as in a mine one may meet with a fissure that, once dividing the "country," but subsequently filled by rocky matter, cuts across the course of a mineral vein which itself was originally formed in a similar way; and just as such a cross fissure thus intersecting with the original metalliferous vein often gives us evidence of a *heave*, i.e. that one side of the new fissure has slid upwards or downwards along the other, so an exactly similar thing is met with in meteorites, and is admirably seen in the microscopic sections of them.

Such a fissure will sometimes divide several spherules lying on its track, the two sides of the fissure having slid, the one along the other. The corresponding halves of the spherules are in such cases separated to some distance along the fissure, and this is itself filled with the vein of meteoric iron or troilite, in some cases with a black fused substance, like the crust of a meteorite.

In passing next to the consideration of the chemistry of meteorites, one of the first inquiries that suggests itself is whether and to what extent the elementary composition of these cosmical rock-fragments accords with that of our own world, or with the revelations which the prism has afforded us regarding the constitution of the matter in energetic action on the surface of our sun, or of those far distant suns, the stars; or, again, in those still uninterpreted assemblages of luminous matter that we call the nebulæ. Now, the elements that have been already recognised by analysis as existing in meteorites form a list that comprises one-third of all the elements known to our chemistry; and these, the more abundant elements on our world. They are—

Hydrogen
Lithium
Sodium
Potassium
Magnesium
Calcium
Aluminium
Titanium
Chromium
Manganese
Iron
Nickel
Cobalt
Copper
Tin
Antimony
Arsenic
Vanadium ?
Phosphorus
Sulphur
Oxygen
Silicon
Carbon
Chlorine

Now, of these elements, those in italics have also been found by the spectroscope to be constituents of the solar surface, together with zinc, strontium, and cadmium, which metals have not yet been met with in meteorites.

The number of elements recognised as existing in activity on the solar orb will undoubtedly be largely increased with the progress of the combined study of the solar spectrum and of the conditions under which the several lines belonging to the different elements are developed. It is by study of this kind that Mr. Lockyer has detected potassium in the sun. The fact that at the present time all the elements detected in the sun excepting three are met with in meteorites, while on the other hand the meteorites contain five metals not as yet found in the sun, at the same time that the six metalloids found in them are so strangely all apparently absent from the surface of our great luminary, might seem to place difficulties in the way of our recognising a general unity of elementary composition in the matter that composes the various orbs and wandering masses that pervade our universe.

But it is clear, on the other hand, that it is too early as yet to look on these results as establishing even probable exceptions to such a unity.

That carbon, sulphur, potassium, and phosphorus, elements so frequently met with in meteorites and on our globe, should, with nitrogen, be absent or have escaped detection among the elements involved in the active operations on the surface of the sun, is certainly not a little surprising. Nor is the failure of the prism to detect the lines due to oxygen and silicon among those presented by the solar photosphere to be accounted for by assuming the persistency of particular silicates in resisting decomposition or vaporisation even in a solar temperature, for Von Rath has shown that silicates such as augite and leucite are actually deposited by a process of sublimation even at the comparatively low temperatures of our volcanoes. Yet it is difficult to believe that the last-mentioned elements can be absent from the great central body of our system, whether we reason from analogy, from their great importance in the composition of our earth, or from the more than probability that these elements must have been contributed to a large amount to the material of the sun by meteoric matter falling into his surface.

Mr. Lockyer has indeed grasped this difficulty with a bold hand, and has not hesitated to declare as a probable explanation of the results obtained from the spectra of the reversing layer and chromosphere of the sun, that the elements exist there not in a molecular but in an atomic condition; and he further assumes that the metalloids exist in a more simple elementary condition than that in which we know them; their terrestrial existence being assumed to be that of compounds which have yet to be resolved into their constituents by our chemistry, though under the fierce chemistry of the sun it is only as thus resolved that they exist on his surface. It is startling for the chemist to be thus called upon to believe that enormous temperatures are endowed with a dissociating power, capable of not merely severing the bonds of ordinary chemical combination, but further of forcing into a condition of ultimate atomic disintegration composite molecules where these are the form under which the chemist has learnt to recognise the ordinary condition of even the isolated elements. Certainly the concordance of the heights to which the different gaseous elements rise in the reversing layer with the weights of the atoms of those elements as represented by their equivalents in the older chemistry, would lend something more than a justification to the even bolder hypothesis that recognises in the metalloids (such as silicon, sulphur, and oxygen, as they exist in our world) compounds of other and to our chemistry unknown elements, were we able to assert that the gaseous molecules of the metals in question, other than hydrogen, potassium, and sodium, must necessarily, like those of these elements, be double. It would be, in any case, a splendid result of solar physics to establish the nature of the gaseous molecules of so many elements that have as yet defied the experimental methods of our terrestrial laboratories. The banded character of the spectra of so many of these metalloids has lent a really important argument to Mr. Lockyer in his bold speculation as to their compound nature, in consequence of its parallelism with the case of compound gases, and his hypothesis has the merit of giving thus an explanation of the apparent absence of elements that every argument would lead us to look for, founded on a principle as ingenious as it is bold in its application.

The recognition by Mr. Huggins in the spectra of the stars of the lines belonging to hydrogen, sodium, magnesium, calcium, and iron, and of carbon compounds in comets and nebulæ, tends strongly to confirm the probability of a general identity in the chemical nature of the matter which pervades our universe; and further shows that the results of these investigations present no obstacle to our drawing any conclusion to which the logic of facts might otherwise guide us as to meteorolitic matter having been in its origin foreign to the solar system. Observations by v. Konkoly of the magnesium, sodium, and possibly also iron lines in the August meteoric swarm, like those by Alexander Herschel of the sodium line in those same St. Lawrence meteors, are of value as extending the coincidence in the elementary constitution of the sun, the stars, and meteorites, to those minuter forms of meteoric matter which, by their dispersion in the atmosphere, have hitherto been unattainable for the purposes of investigation.

In passing from the merely elementary components of meteorites to the chemical forms—that is to say, to the minerals in which these elements are grouped in them, we find ourselves in the presence of aggregates of crystallised minerals that at once remind us of our terrestrial rocks. At a first aspect they might easily be taken for rocks formed under conditions not very different from those of our globe. A closer inspection, however, brings out distinctive characters in these that evidence a very different set of conditions as having prevailed in the formation of the meteoric and the terrestrial rocks. Without going into minute mineralogical variations, and needlessly multiplying names, we may tabulate in a very short list the constituent minerals of the different sorts of meteorites. Several of these minerals are nearly identical in composition and crystallographic character with corresponding minerals met with in terrestrial rocks; others again are unknown, while some of them could hardly exist permanently as terrestrial minerals; and two present the composition of minerals familiar to us in our own rocks, but crystallographically distinct from these as belonging to different types of symmetry or "systems" from theirs.

In the Elementary Condition.

Iron with Nickel, traces of Cobalt and Copper, in some and probably in all cases with Hydrogen, Carbonic oxide, or other gases occluded in the metal.

Carbon (graphitic and plumbaginous).

Sulphur.

Compounds.

Ferrous Sulphide (*Troilite*)	FeS
Magnetic Pyrites	Fe_7S_8
Magnesium Sulphide ?	MgS
Calcium Sulphide (*Oldhamite*)	$Ca(Mg)S$
A Titanium—Calcium Sulphide (*Osbornite*)	?
Magnetite	Fe_3O_4
Chromite	$(FeCr)_3O_4$
Silica (orthorhombic as *Asmanite*)	SiO_2
,, (hexagonal as Quartz) ?	
Tin Oxide	SnO_2
Silicates, viz. :—	
Olivine varieties	$\left(Mg_{\frac{n}{m}}Fe_{\frac{m-n}{m}}\right)_2SiO_4$
Enstatite	$MgSiO_3$
Bronzite varieties	$\left(Mg_{\frac{n}{m}}Fe_{\frac{m-n}{m}}\right)SiO_3$
Augite varieties	$\left(Mg_{\frac{n}{m}}Ca_{\frac{m-n}{m}}\right)SiO_3$
,, varieties containing corresponding ferrous silicate.	
Anorthite	$CaAl_2SiO_8$
Labradorite ?	
,, in tesseral forms (Tschermak's Maskelynite).	
Schreibersite varieties (phosphides of iron and nickel).	
Hydrocarbons (not yet sufficiently investigated).	

The names printed in italics are thus new to our mineralogy. The mineral to which I originally gave the name of Oldhamite is in all probability a mixture of two minerals—a Calcium Sulphide (which would be the pure Oldhamite) and a Magnesium Sulphide; and it is probable that they are not uncommon, though sparsely scattered, ingredients in freshly fallen meteorites, which, however, the action of a damp atmosphere rapidly decomposes into calcium sulphate or carbonate, and free sulphur, all which minerals occur in minute quantities occasionally in meteorites after they have been exposed to the weather.

Until the year 1867 the mineralogical department at the British Museum was without a laboratory, and chemical analyses could not be performed. I accordingly had recourse in 1861 to microscopic investigation as my only means of attacking the mineralogical problems presented by meteoric rocks. By the use of polarised light, of which the position of the plane of polarisation was accurately determined, it was possible, by the aid of an eyepiece goniometer and also of a revolving stage, to determine with some precision the directions of the principal sections in any of the minute sections of crystals which a fragment of a meteorite worked down to a thin transparent slice might present. Where such crystal sections happened to be approximately parallel to a zone plane, and the traces of the faces belonging to the zone could be seen with sufficient sharpness, or where cleavage planes occurred parallel or at recognisable inclinations to faces of the zone, important decisions could be arrived at by aid of polarised light. And this method is now becoming one of great importance to petrologists.

It was thus that I was enabled to anticipate with much confidence the orthorhombic character of one and the clinorhombic character of another ingredient (the enstatite and augite) in the Busti meteorite, and determine the cubic character of the oldhamite in that meteorite in 1862; and to be the first to announce the more than probability of enstatite (including of course, as the term then did, bronzite) being an important ingredient in meteorites; in the case of the Nellore meteorite in June 1863 and of that of Kaee in August 1864; a view confirmed afterwards (in November 1864) by Dr. Lawrence Smith on his repeating his analysis of the meteorite of Bishopville. Of the meteorites of Busti and of Manegaum, before they were cut, only minute fragments were at my disposal; and though in naming and first describing oldhamite in 1862, I had spoken of it as having all the appearance of being a "calcium galena," a small amount of probably sulphur and gypsum that separated in the watch-glass in which I made a qualitative investigation of it constrained me to say that I believed it to contain an excess of sulphur beyond that in the neutral sulphide.

Of the Manegaum meteorite also I employed only a minute fragment for investigation, and I attributed the bronzite of that meteorite to olivine, the section of the crystal examined not being really parallel to a zone-plane, and was confirmed in this error by finding the powdered bronzite not to be insoluble in acids. The addition of a laboratory to the department in 1867 enabled the long-desired analysis of the minerals I had separated to be made; and Dr. W. Flight being at my request appointed chemical assistant, I was able, with the help of his analytical skill, to complete the account of the minerals the presence of which in the meteorites in question had been determined so many years before.

The separated sulphur in the oldhamite proved, when a sufficient amount was taken for investigation, to be due to a superficial decomposition of the mineral, while bronzite was shown to be distinctly soluble in acid. The methods I adopted for the investigation of meteorites have since been employed by other observers, as well in the mode of using the directions of the principal sections of crystal-sections in the microscopic examination of terrestrial rocks as in the mode of attacking a meteorite by separating and isolating by toilsome microscopic selection its ingredient minerals; the plan by which the silicates in the Breitenbach siderolite and also those in fresh amounts from the Busti aërolite had been separated with a view to analysis in 1864 and 1865. Viktor von Lang, to whose assistance and to whose friendship I owe two or three of the most valued years of my life, while he was my colleague, measured, and some time afterwards published the account of the crystals of bronzite in the Breitenbach meteorite; the first occasion on which the crystallography of that mineral had been made out, only the system and approximate prism angle of the terrestrial bronzite and enstatite being previously known through the optical researches of Des Cloizeaux.

The form of asmanite, the orthorhombic variety of silica, occurring in the same meteorite, offered a difficult problem which I had taken in hand. One little crystal, however, carrying a portion of a zone with four consecutive faces, picked out in 1867, furnished the final key to its crystallography.

N. S. MASKELYNE

(*To be continued.*)

INSTINCT AND ACQUISITION.*

SO great was the influence of that school of psychology which maintained that we and all other animals had to acquire in the course of our individual lives all the knowledge and skill necessary for our preservation, that many of the very greatest authorities in science refused to believe in those instructive performances of young animals about which the less learned multitude have never had any doubt. For example, Helmholtz, than whom there is not, perhaps, any higher scientific authority, says: "The young chicken very soon pecks at grains of corn, but it pecked while it was still in the shell, and when it hears the hen peck, it pecks again, at first seemingly at random. Then, when it has by chance hit upon a grain, it may, no doubt, learn to notice the field of vision which is at the moment presented to it."

At the meeting of this Association in 1872, I gave a pretty full account of the behaviour of the chicken after its escape from the shell. The facts observed were conclusive against the individual-experience psychology. And they have, as far as I am aware, been received by scientific men without question. I would now add that not only does the chick not require to learn to peck at, to seize, and to swallow small specks of food, but that it is not a fact, as asserted, and generally supposed, that it pecks while still in the shell. The actual mode of self-delivery is just the reverse of pecking. Instead of striking forward and downward (a movement impossible on the part of a bird packed in a shell with its head under its wing), it breaks its way out by vigorously jerking its head upward, while it turns round within the shell, which is cut in two—chipped right round in a perfect circle some distance from the great end.

Though the instincts of animals appear and disappear in such seasonable correspondence with their own wants and the wants of their offspring as to be a standing subject of wonder, they have by no means the fixed and unalterable character by which some would distinguish them from the higher faculties of the human race. They vary in the individuals as does their physical structure. Animals can learn what they did not know by instinct and forget the instinctive knowledge which they never learned, while their instincts will often accommodate themselves to considerable changes in the order of external events. Everybody knows it to be a common practice to hatch ducks' eggs under the common hen, though in such cases the hen has to sit a week longer than on her own eggs. I tried an experiment to ascertain how far the time of sitting could be interfered with in the opposite direction. Two hens became broody on the same day, and I set them on dummies. On the third day I put two chicks a day old to one of the hens. She pecked at them once or twice; seemed rather fidgety, then took to them, called them to her and entered on all the cares of a mother. The other hen was similarly tried, but with a very different result. She pecked at the chickens viciously, and both that day and the next stubbornly refused to have anything to do with them.

The pig is an animal that has its wits about it quite as soon after birth as the chicken. I therefore selected it as a subject of observation. The following are some of my observations:—That vigorous young pigs get up and search for the teat at once, or within one minute after their entrance into the world. That if removed several feet from their mother, when aged only a few minutes, they soon find their way back to her, guided apparently by the grunting she makes in answer to their squeaking. In the case I observed the old sow rose in less than an hour and a half after pigging, and went out to eat; the pigs ran about, tried to eat various matters, followed their mother out, and sucked while she stood eating. One pig I put in a bag the moment it was born and kept it in the dark until it was seven hours old, when I placed it outside the sty, a distance of ten feet from where the sow lay concealed inside the house. The pig soon recognised the low grunting of its mother, went along outside the sty struggling to get under or over the lower bar. At the end of five minutes it succeeded in forcing itself through under the bar at one of the few places where that was possible. No sooner in than it went without a pause into the pig-house to its mother, and was at once like the others in its behaviour. Two little pigs I blindfolded at their birth. One of them I placed with its mother at once: it soon found the teat and began to suck. Six hours later I placed the other a little distance from the sow; it reached her in half a minute, after going about rather vaguely; in half a minute more it found the teat. Next day I found that one of the two left with the mother, blindfolded, had got the blinders off; the other was quite blind, walked about freely, knocking against things. In the afternoon I uncovered its eyes, and it went round and round as if it had had sight, and had suddenly lost it. In ten minutes it was scarcely distinguishable from one that had had sight all along. When placed on a chair it knew the height to require considering, went down on its knees and leapt down. When its eyes had been unveiled twenty minutes I placed it and another twenty feet from the sty. The two reached the mother in five minutes and at the same moment.

Different kinds of creatures, then, bring with them a good deal of cleverness, and a very useful acquaintance with the established order of nature. At the same time all of them later in their lives do a great many things of which they are quite incapable at birth. That these are all matters of pure acquisition appears to me an unwarranted assumption. The human infant cannot masticate; it can move its limbs, but cannot walk, or direct its hands so as to grasp an object held up before it. The kitten just born cannot catch mice. The newly hatched swallow or tomtit can neither walk, nor fly, nor feed itself. They are as helpless as the human infant. Is it as the result of painful learning that the child subsequently seizes an apple and eats it? that the cat lies in wait for the mouse? that the bird finds its proper food and wings its way through the air? We think not. With the development of the physical parts, comes, according to our view, the power to use them, in the ways that have preserved the race through past ages. This is in harmony with all we know. Not so the contrary view. So old is the feud between the cat and the dog, that the kitten knows its enemy even before it is able to see him, and when its fear can in no way serve it. One day last month, after fondling my dog, I put my hand into a basket containing four blind kittens, three days old. The smell my hand had carried with it set them puffing and spitting in a most comical fashion.

That the later developments to which I have referred are not acquisitions can be in some instances demonstrated. Birds do not *learn* to fly. Two years ago I shut up five unfledged swallows in a small box not much larger than the nest from which they were taken. The little box, which had a wire front, was hung on the wall near the nest, and the young swallows were fed by their parents through the wires. In this confinement, where they could not even extend their wings, they were kept until after they were fully fledged. Lord and Lady Amberley liberated the birds and communicated their observations to me, I being in another part of the country at the time. On going to set the prisoners free, one was found dead—they were all alive on the previous day. The remaining four were allowed to escape one at a time. Two of these were perceptibly wavering and unsteady in their flight. One of them, after a flight of about ninety yards, disappeared among some trees; the other, which flew more steadily, made a sweeping circuit in the air, after the manner of its kind, and alighted, or attempted to alight, on a branchless stump of a beech; at least it was no more seen. No. 3 (which was seen on the wing for about half a minute) flew near the ground, first round Wellingtonia, over to the other side of the kitchen-garden, past the bee-house, back to the lawn, round again, and into a beech-tree. No. 4 flew well near the ground, over a hedge twelve feet high to the kitchen-garden through an opening into the beeches, and was last seen close to the ground. The swallows never flew against anything, nor was there, in their avoiding objects, any appreciable difference between them and the old birds. No. 3 swept round the Wellingtonia, and No. 4 rose over the hedge just as we see the old swallows doing every hour of the day. I have this summer verified these observations. Of two swallows I had similarly confined, one, on being set free, flew a yard or two too close to the ground, rose in the direction of a beech-tree, which it gracefully avoided; it was seen for a considerable time sweeping round the beeches and performing magnificent evolutions in the air high above them. The other, which was observed to beat the air with its wings more than usual, was soon lost to sight behind some trees. Titmice, tomtits, and wrens I have made the subjects of a similar experiment and with similar results.

Again, every boy who has brought up nestlings with the hand must have observed that while for a time they but hold up their heads and open their mouths to be fed, they by-and-by begin quite spontaneously to snap at the food. Here the development may be observed as it proceeds. In the case of the swallow I am inclined to think that they catch insects in the air perfectly well immediately on leaving the nest.

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* Read at the Bristol meeting of the British Association.

With regard, now, to man, is there any reason to suppose that, unlike all other creatures, his mental constitution has to be in the case of each individual built up from the foundation out of the primitive elements of consciousness? Reason seems to me to be all the other way. The infant is helpless at birth for the same reason that the kitten or swallow is helpless—because of its physical immaturity; and I know of nothing to justify the contrary opinion, as held by some of our distinguished psychologists. Why believe that the sparrow can pick up crumbs by instinct, but that man must learn to interpret his visual sensations and to chew his food? Dr. Carpenter, in his "Mental Physiology," has attempted to answer this argument in the only way in which it could be answered. He has produced facts which appear to him to prove "that the acquirement of the power of visually guiding the muscular movements is experimental in the case of the human infant." More than forty years ago Dr. Carpenter took part in an operation performed on a boy three years old for congenital cataract. The operation was successful. In a few days both pupils were almost clear; but though the boy "clearly recognised the *direction* of a candle or other bright object, he was unable as an infant to apprehend its *distance;* so that when told to lay hold of a watch he groped at it just as a young child lying in its cradle." He gradually began to use his eyes; first in places with which he was not familiar, but it was several months before he trusted to them for guidance as other children of his age would do. No one will doubt the accuracy of any of these statements; but I cannot agree with Dr. Carpenter that he had in the case of the boy anything "exactly parallel" to my experiment of hooding chickens at birth and giving them their sight at the end of one or two days. This boy was couched when three years old. Probably sight would have been at first rather puzzling to my chickens, had they not received it until they were six months old. Dr. Carpenter seems to have forgotten for the moment that instincts as well as acquisitions decay through desuetude, and that this is especially true when the faculties in question have never once been started into action and are of the kind which develop through exercise. Another and vital difference between Dr. Carpenter's experiment and mine is this, that when at the end of two days I gave my chickens sight, I did not do so by poking out or lacerating the crystalline lenses of their eyes with a needle.

The presumption, then, that the progress of the infant is but the unfolding of inherited powers remains as strong as ever. With wings there comes to the bird the power to use them; and why should we believe that because the human infant is born without teeth, it should, when they do make their appearance, have to discover their use by a series of happy accidents?

One word as to the origin of instincts. In common with other evolutionists, I have argued that instinct in the present generation may be regarded as the product of the accumulated experiences of past generations. More peculiar to myself, and giving a special meaning to the word experience, is the view that the question of the origin of the most mysterious instincts is not more difficult than, or different from, but is the same with the problem of the origin of the physical structure of the creatures. For, however they may have come by their bodily organisation, it, in my opinion, carries with it a corresponding mental nature.

In opposition to this view it has been urged that we have only to consider almost any well-marked instinct to see that it could never have been a product of evolution. We, it is said most frequently, cannot conceive the experiences that might by inheritance have become the instincts; and we *can* see very clearly that many instincts are so essential to the preservation of the creatures that without them they could never have lived to acquire them. The answer is easy. Granting our utter inability to go back in imagination through the infinite multitude of forms, with their diversified mental characteristics, that stand between the greyhound and the speck of living jelly to which, according to the theory of evolution, it is related by an unbroken line of descent. Granting that we are, if possible, still less able to picture in imagination the process of change from any one form to another. What then? Not surely that the theory of evolution is false! For the same argument will prove that no man present can possibly be the son of his father. Our ignorance is very great, but it is not a very great argument.

The other objection, that the creatures could never have lived to acquire their more important instincts, rests on a careless misunderstanding of the theory of evolution. It assumes in the drollest possible way that evolutionists must believe that in the course of the evolution of the existing races there must have from time to time appeared whole generations of creatures that could not start on life from the want of instincts that they had not got. There can be no need to say more than that these unfortunate creatures are assumed to have been singularly unlike their parents. The answer is, that it is not the doctrine of evolution that the bodies are evolved first by one set of causes and the minds are put in afterwards by another. This notion is but the still lingering shadow of the individual-experience psychology. As evolutionists, whether we take the more common view and regard the actions of animals as prompted by their feelings and guided by their thoughts, or believe, as I do, that animals and men are conscious automata, in either case we are under no necessity of assuming in explanation of the origin of the most mysterious instincts anything beyond the operation of those laws that we see operating around us, but concerning which we have yet to learn more, perhaps, than we have learned.

D. A. SPALDING

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Sept. 20.—*Résumé* of the observations of the sun and of the planets Mercury, Venus, Mars, Jupiter, Saturn, and Uranus, made at the Paris Observatory during the year 1874, by M. Leverrier.—On a remarkable anatomical peculiarity of the rhinoceros, by MM. Paul and Henri Gervais.—Addition to the note relating to M. Bienaymé's theorem, by M. J. Bertrand.—Chemical and spectroscopic characters of a new metal, Gallium, discovered in a blende from the Pierrefitte mine, Argeles Valley, Pyrenees, by M. Lecoq de Boisbaudran. An account of this metal has already appeared in our columns.—Theorem on the composition of co-variants, by M. C. Jordan.—Preliminary note on the function of the protective sheath in herbaceous Dicotyledons, by M. J. Vesque.—On a vertical column of vapour observed from a balloon, by M. W. de Fonvielle.—On the development and structure of interior foliaceous glands, by M. Joannes Chatin.—Existence and development of the *Avicula contorta* zone in the Isle of Corsica, by MM. L. Dieulafait and Hollande.—On the theory of hail, by M. E. Renou.—On hailstones picked up at Criel-sur-Mer during the storm of August 12, 1875, by M. A. Landrin.

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ERRATUM.—P. 301, line 24, for "blackened temperature" read "maximum temperature."

THURSDAY, OCTOBER 14, 1875

THE INAUGURATION OF THE YORKSHIRE COLLEGE OF SCIENCE

THE formal opening of the College of Science at Leeds by the Duke of Devonshire, which we briefly announced last week, is an event of no mean importance to the county, and of no small interest to the rest of the community, inasmuch as we must regard it as another indication of the great educational movement which has already been experienced by Manchester, Newcastle, Birmingham, and Bristol, and is beginning to be felt more or less strongly in every industrial centre throughout the country. This movement, as Mr. Forster tells us, is not merely to give education to the captains of industry; it is to increase the culture of every individual working man and working woman in the land, and to give them not elementary education alone, but skilled knowledge to enable them to earn their living as efficiently as possible by affording them the key to the stores of knowledge.

It really appears that at last, in this county utterly devoid of any organisation for anything but the lowest education, there are persons who are gradually realising the fact, the statement of which has been dinned into our ears by the best informed minds for more than a quarter of a century, that the industrial supremacy of this country depends on other factors than natural resources, mental vigour, industry, and perseverance. The illustrious Liebig more than a generation ago, and in the very town which witnessed the ceremony of last week, warned us how impossible it was for England permanently to preserve this supremacy unless she bestowed more attention on the sciences which formed the basis of her chief industries. Nothing could be happier than the coincidence that Dr. Playfair, who then interpreted this memorable saying of the great German philosopher, should be present to see the Yorkshire people establishing an educational organisation, which is in no small degree the outcome of the counsel given to them so long ago. Truly the bread cast upon the waters has returned to Leeds after many days. And now let the promoters of the Yorkshire College take heed to the words of counsel given by the many eminent men whom they invited to take part in the opening ceremony. If the county is as earnest in furthering its welfare as we believe it to be, the institution ought not to remain long on its present limited basis: we hope and trust that the opinion of its President, Lord Frederick Cavendish, that to restrict the College to natural science would make it "a one-legged, one-sided concern," is shared by the rest of the Council. We do not want a Yorkshire College of Science, but a Yorkshire College in which science will be found in its proper place. It must be remembered that the whole duty of these local colleges is not limited to the instruction in the particular sciences which more directly relate to the manufacturing industries of the districts in which they are placed; they must be made to act as *nuclei* for higher culture by the establishment of chairs of Art and Literature. As Dr. Playfair told the people of Leeds, "a College of Science, such as we are inaugurating to-day, is admirable in itself, but it is not complete. Perhaps it even focusses the light too strongly on a particular spot, and for this reason it intensifies the darkness around. Its directors are too enlightened men not to see this, and I am sure they will aid in the co-ordination of your other educational resources." We are aware that the establishment of an institution on so broad a basis as we have indicated is a work of time and patience, but that it can be accomplished, and in the face of great disadvantages, is evident from the example of Owens College. There are doubtless special difficulties in the case of the Yorkshire College; no John Owens has yet come to its aid with a munificent endowment, nor has it the advantage of being connected with an established institution in the manner that the Newcastle College is affiliated to Durham, or the proposed Bristol College to Oxford.

Yorkshiremen are proverbially a hard-headed race, with a keen eye to immediate practical benefits, but they must have patience, not forgetting that institutions similar to their own College have had their day of small things, and that it has needed much money and much time before their advantages have been fully realised. We have just one more word of advice and caution. The wealthy manufacturers who, roused by the fear of foreign competition and the cry for technical education, aid the struggling institution with their money, may be too apt to demand the establishment of technical classes as the condition of their support; and in consequence of the outside pressure thus exerted on the government of the College, it may be driven to regard such classes as the main feature of the work of the professors and lecturers.

We would counsel the College authorities to weigh well the words of the gentleman whose advice they specially asked. Dr. Playfair warned them against giving the College too much of a technical character, at least in its infancy. "The object of education, even in a technical school, is not to teach men how to use spinning jennies or steam-hammers, but it is to give a cultured intelligence which may be applied to work in life, whatever that may be. Teach science well to the scholars, and they will make the applications for themselves. Good food becomes assimilated to its several purposes by digestion. Epictetus used to say that though you feed sheep on grass, it is not grass but wool which grows upon their backs. So if this College teach science as a branch of human culture, it will reappear as broad cloth, worsted, puddled iron, or locomotives, according to the digestive capacities of the Leeds manufacturers who consume it."

BURTON'S "ULTIMA THULE."

Ultima Thule; or, a Summer in Iceland. By Richard F. Burton. With Historical Introduction, Maps, and Illustrations. Two vols. (Edinburgh and London: W. P. Nimmo, 1875.)

OF the 780 pages which make up these two handsome volumes, only one half is occupied with an account of Capt. Burton's doings in Iceland during the summer, June to September 1872, which he spent there. No one, of course, can conceive Capt. Burton having any temptation to the production of a mere big book, and we have no doubt that his object has been to enlighten the British public as to the real condition of Iceland and its interesting people. Indeed he hints as much in his preface; "the main object of the book," he says, "has been to advocate the development of the island."

Capt. Burton's method of accomplishing his object will, certainly be effective with those who take a real interest in Iceland, and who are willing to take the trouble to master the contents of his two volumes. The Introduction, covering 260 pages, consists of a condensed mass of facts compiled from many sources, relating to Iceland in all its aspects, and he who studies them thoroughly will be well rewarded for his pains; besides the mere pleasure of adding to his knowledge, he will possess an excellent vantage-ground from which to watch the progress of the island and any future attempts that may be made to increase our knowledge of it. Iceland is gradually becoming a popular tourist-ground, and when good hotels are built and the means of travel are improved and organised, no doubt it will be included in the programme of the omnipresent Cook. Intending travellers, as well as all who desire to see the most trustworthy information about Iceland put in an accessible form, ought to feel grateful to Capt. Burton. He has indeed acted in a very unselfish manner in thus compiling what is really a valuable monograph on Iceland, instead of concentrating the attention of the public exclusively on himself and his own experiences in the country. So great an explorer as Capt. Burton has long ago proved himself to be would have been perfectly justified in so doing, and therefore the voluntary service he has rendered to Iceland and the British public is all the more enhanced.

There has been a great deal more written about Iceland than most people are aware of; in his Introduction, Mr. Burton gives a list of no less than fifty works, mostly English narratives of travel, which have been written during the present century, not to mention all that has been written in previous centuries. The author has not, however, confined himself in collecting his facts and theories to what has been published, but has drawn largely on the liberality of willing friends who have made special studies of various points connected with the country, its history, and its people. The result is, we believe, a handier and more complete account of Iceland than will be found in any other single work.

The first section of the Introduction treats "Of Thule," and consists of a formidably learned discussion as to the applications which the classical term has had in various writers and at various times, from Pytheas of Marseilles downwards. Of course the important point in such a discussion is to ascertain what Pytheas meant by the term; and although it seems to us that the few details concerning "Thule" which have been preserved apply more appropriately to Iceland than to any other country which has been proposed, we are inclined to doubt with St. Martin ("Histoire de Géographe," p. 104) whether Pytheas ever saw the country, and to think it more probable that he got his accounts from the inhabitants of North Britain. This, however, is not the place to discuss such a question, even had we space. Capt. Burton, who seems to take delight in advocating improbable theories, makes much more than we think the evidence justifies of the few ecclesiastical remains which the first Norsemen found on the island, and of the traditions concerning the Irish ecclesiastics who at one time found their way to the coasts. These latter no doubt found their way to Iceland at first by accident; afterwards very probably they may have resorted to it in considerable numbers because there they could live in retirement "far from all men's knowing." But, apart from these Irish priests, Mr. Burton is inclined to believe that Iceland may have had a considerable prehistoric population, the remains of which he does not despair of seeing brought to light. At present there is no evidence whatever on which to base such a belief, and had any such population ever existed in the island, we may be almost certain that some indications of its existence would have been met with during the thousand years that the Norse have possessed it. The Bull of Gregory IV., dated about 835 A.D., in which Iceland and Greenland seem to be mentioned, cannot but be regarded with the gravest suspicion, and we have a strong impression that quite recently conclusive proof has been found that the names of these two countries are interpolations.

Capt. Burton concludes this section by referring to the various etymologies that have been proposed for the term "Thule;" we dare say most readers will be struck with the hopelessness of ever finding an origin for the word, and with the utterly improbable theories which the most learned men allow themselves to advance. Here we may remark that one of the notable points of the work before us is etymology; Capt. Burton seldom, we might with confidence say never, introduces a Norse word—and his pages bristle with them—without giving its etymology. This is a most commendable feature, though its value is much diminished by the want of a sufficient index, the three pages at the end of the work being quite inadequate to a book so rich in facts of all kinds. We think it would have added to the value of the work and the comfort of the reader, if a special etymological index had been given. Capt. Burton's flights into comparative etymology are sometimes of the most daring kind. And the reckless way in which he resorts to Semitic and even Turanian languages for congeners to Aryan roots and even Teutonic words, will rather astonish sober students of the science of language.

Besides a sketch of the history of Iceland, the author furnishes in the Introduction valuable details concerning the following matters:—Physical Geography, including Geology, Hydrography, Climate, Chronometry, &c.; Political Geography, Anthropology, Education and Professions, Zoological Notes (including notes on the Flora, Agriculture, Fishing, Industry, &c.), Taxation, and a *Catalogue-raisonné* of Modern Travels in Iceland, besides instructions as to what preparations an intending traveller ought to make. Under these various heads there are many points we should like to notice did space permit; under all of them the reader will find a vast amount of useful information, which it must have taken Captain Burton no little trouble to collect and condense. In speaking of the climate, Capt. Burton doubts much if the Gulf Stream has anything to do with its comparative mildness, and especially the commonly accepted theory that a branch of the great "river in the ocean" bifurcates off the south-west corner, one arm proceeding northward and the other along the south coast, both reuniting in the North Atlantic between Iceland and Norway. We have certainly much yet to learn about the causes which contribute to form the climate of a country, but without the action of some such influence as would be derived from the Gulf Stream, it seems to us difficult to account for the comparatively mild climate of Iceland as contrasted with the decidedly Arctic climate of countries in the same latitude. But this is a dangerous question to enter upon; what is wanted at present is not so much discussion as facts.

Capt. Burton tells us in his preface that he "went to Iceland feeling by instinct that many travellers had prodigiously exaggerated their descriptions, possibly because they had seldom left home." Stay-at-home people will therefore be grateful that so experienced a traveller and so trained an observer as Capt. Burton has gone over the old ground and told them in a plain, matter-of-fact, yet exceedingly graphic way, what is actually to be seen. In his account of his tour the usual "stupendous" writing will not be found, and many indeed may be inclined to think that the narrative has too much of the "nil admirari" spirit about it. This is not our opinion: Capt. Burton shows frequently throughout the work that he is quite prepared to admire all that is admirable in the country and its people, and concerning the latter especially, it was quite time that we should have a sober and trustworthy account. Travellers hitherto have been too much inclined to look upon the Icelander under quite an auroral glow, as a descendant of the "Hardy Norseman" with his traditional tawny beard, fair hair, brawny build, splendid fighting qualities, with an infusion of rude gentleness. The Icelander is no doubt a descendant of the dauntless men who contributed their share in the building up of the English people, but there seems little reason to doubt that he is a degenerate one. If we can believe Capt. Burton, as well as the reports of some other recent travellers, the chief virtue of the Icelander is laziness, which keeps him as well from doing harm as positive good. Even that gentleness of manner and primitive simplicity of social intercourse which early travellers tell us characterised the people, seem to be rapidly leaving them. But this is inevitable, and from a practical and humane point of view not to be regretted; it is the first stage in the breaking up of their long lethargy, and to doing away with a condition of society which is really an anachronism. There does not seem to be native energy sufficient to the development of the resources of the country, and it is well that foreign attention and foreign capital should be drawn to it, [especially with an eye to the no doubt extensive sulphur resources; we believe such intercourse would benefit the Icelanders by bringing them, with all their dormant good qualities, into the active life of the present.

It is unnecessary to follow Capt. Burton in what was to a great extent a tour, though an unusually critical one, over previously trodden ground, rather than a journey of exploration. He begins at the end with pretty full notes of a visit to Orkney and Shetland, which he paid on his return from Iceland. Concerning the prehistoric and other antiquities of these islands he has of course something to say, and we commend his criticisms to the antiquarian. In Iceland he stayed some time at Reykjavik before setting out to explore the island, and concerning the capital, its institutions and people, as well as what is to be seen in the neighbourhood, he has much to say, finding a little to praise and a great deal to blame. The Icelander can obtain a very fair education in his own country, with even a smattering of science, and it seems to us that it would not take much to convert the High School of Reykjavik into a really good high-class school. Much has been expected to result from the new constitution granted to Iceland last year; we have no doubt that this, combined with other new influences, will have a good effect upon what we cannot but regard after all as a healthy scion of a good stock. After spending some days at the capital Capt. Burton set out on a trip to the north in the *Jón Sigurðsson* steamship. The principal features of the west and north-west coast are described with considerable minuteness, and many interesting details given concerning the various places at which the steamer stopped—Stykkishólm, Flatey, Eyri or Isafjörd, Borðeyri, and Grafarós, the termination of the trip. At every stopping-place Capt. Burton used the short time at his disposal most industriously in making himself acquainted with whatever was noteworthy. Some space is devoted to the Snæfellsjökull (4,577 Danish feet) and its associations, and to the striking features which characterise the bold north-west peninsula.

On his return from the northern trip, Capt. Burton made the popular round from Reykjavik by the Krisuvik sulphur springs, Hekla, the Geysirs, Thingvellir, back to the starting-point. Here his observations are especially minute, and his descriptions somewhat photographic, as it is in reference to this region that previously travellers have been specially exaggerative. Capt. Burton has of course seen too much of some of the most "stupendous" scenery in the world to be much impressed with any of the features to be seen in this often travelled round. It is evident, however, that he desired to observe without bias, and to record impartially what he saw; and if at times he seems too depreciatory, there is ample excuse for his measured statements in the irritation naturally caused by the ecstatic descriptions of previous travellers. With regard to the sulphur deposits at Krisuvik and in the My-vatn district, ample information will be found in the work; Mr. Vincent's paper read at the Society of Arts is reproduced, and a considerable appendix is devoted to the subject, consisting of papers by various authorities who have given attention to the subject. Capt. Burton himself seems to think that much more can be made out of the My-vatn district than out of that of Krisuvik.

Hekla, Capt. Burton speaks of as a humbug, and its ascent mere child's play. "The Hekla of reality is a commonplace heap, half the height of Hermon, and a mere pigmy compared with the Andine peaks, rising detached from the plains. . . . A pair of white patches represent the 'eternal snows.' . . . We [there were two young ladies with him] had nerved ourselves to 'break neck or limbs, be maimed or boiled alive,' but we looked in vain for the 'concealed abysses,' for the 'crevasses to be crossed,' and for places where 'a slip would be to roll to destruction.' We did not sight the 'lava-wall, a capital protection against giddiness.' The snow was anything but slippery." In short, for those who have never seen a volcano, Hekla may be a wonder, but as compared with other volcanoes it is a mere smoking cinder-heap. Whatever may be the value of Capt. Burton's conclusions, his minute comparative study of this notable feature of Icelandic scenery deserves attention. The Geysirs also he inspected with considerable minuteness, and concludes that in their present condition they are "like Hekla, gross humbugs; and if their decline continues so rapidly, in a few years there will be nothing save a vulgar solfatara, 440 by 150 yards in extent." In this connection a pretty full account is given of the various attempts which have been made to account for the action of Geysirs. The whole of this portion of the narrative we deem of special value.

Capt. Burton's final trip was to eastern Iceland. He sailed from Reykjavik to Berufjörð on the east coast. Thence he proceeded with a small cavalcade on ponies north-west by devious ways to the My-vatn, the lake in the neighbourhood of which sulphur is so plentiful. The lake itself and the neighbouring district he describes in considerable detail, and notes carefully the prominent features to be met with in the route from Berufjörð. On his return he attempted to climb the steep pyramidal mountain of Herðubreið (5,447 feet), a few miles south of My-vatn, but after a strenuous effort failed to reach the summit. He also paid a visit to Snæfell and the northern boundary of the great glacier Vatnajökull, which for the first time has been recently crossed by the indomitable Mr. Watts. Capt. Burton speaks of the glacier with considerable enthusiasm, and gives a minute and striking picture of all he was able to observe; and now that Mr. Watts has shown the way, we may hope ere long to have its main features observed and described in detail. While in this region the traveller was in the vicinity of the mysterious central desert of Iceland, the Ódáða Hraun, which the ignorant natives still people with fierce robbers.

Capt. Burton thus nearly accomplished the circuit of the island, and it is impossible in the space at our disposal to give any adequate idea of even his personal narrative. His lively pictures, sketched with the hand of a master, of Icelandic character and of social life among all classes, are specially attractive. Nothing worthy of note escapes his observation, and both the scientific and the "general" reader will find the work to abound in interest and instruction. As a corrective to the usual indiscriminating narrative of Icelandic travel, it is invaluable. As we said at the beginning, the work as a whole will give a better idea of the country from all points of view than any other single work hitherto published.

One of the most marked features in Capt. Burton's style is its digressiveness and excessive allusiveness; in the present work he carries it often to a perplexing extent, and unless the reader be as well-informed as the traveller himself, he is apt to get bewildered. This feature enforces the most careful reading, and we therefore, perhaps, ought not to consider it a fault.

The lithographic and other illustrations which adorn the work are creditably done and add to its value. The general map is very good and useful, but would have been more so had it been on a larger scale. The special map of the My-vatn and Vatnajökull district is excellent. The publisher deserves the word of praise which the author awards him in the preface.

DUPONT AND DE LA GRYE'S "INDIGENOUS AND FOREIGN WOODS"

Les Bois indigènes et étrangers: Physiologie, Culture, Production, Qualités, Industrie, Commerce. Par Adolphe E. Dupont et Bouquet de la Grye. (Paris: Rothschild. London: Asher and Co., and Williams and Norgate.)

THE science of forest conservation, as is well known, is much more carefully attended to in France and Germany than it is in England or even in India, where, indeed, much has been done of late years in the conservation of the valuable timber trees in which the forests of our Eastern Empire abound.

Though it cannot be denied that Scotland turns out some clever foresters, it is in Continental Europe that forestry is taught under a complete system, practical lessons and lectures being conducted in the forests themselves amongst the very objects which it is the aim of the student to become closely acquainted with. The forest, to the young forester, is in every respect what the hospital is to the medical student. In it he sees the various forms of disease or of injury resulting from mismanagement, and by comparison of the effects of judicious and scientific treatment the means of success or failure are practically demonstrated. It is from these facts that the curriculum of training young officers for the Indian forest service, which now obtains, includes a given time of study in France or Germany. In consideration of this established and systematic course of instruction, it is not surprising that there should issue from the Continental press from time to time some valuable works on forest produce, either with regard to the cultivation of the trees or the utilisation and application of their timber.

The work before us is one which we should not expect to be produced in England, except, perhaps, as a translation. It is a bulky book of 552 pages, and is of a very comprehensive nature, including the consideration of all matters connected with trees from the very beginning of life to the commercial aspects of the timber trade. Being the joint production of a naval architect and a conservator of forests, each author has done much towards making the book valuable to all interested in the growth and production of timber.

The first chapter is devoted to the physiology of plants, and occupies 128 pages; rather too much, it must be confessed, when it is borne in mind that a good deal of the ground has been gone over before in most manuals of botany: the latter part of the chapter, however, is interesting, as showing the effects of climate, altitude, rains, &c. Chapter II. treats of cultivation in its various phases, and its effects upon the quality of the woods in a commercial point of view. Passing over the chapter on forest statistics, in which some interesting comparisons are given on the extent of forests in France, Germany, Russia, Sweden, Norway, &c., and passing also that on the working of the forests, in which, however, is a notice on the production of charcoal—essentially a French industry—we come to Chapter V., on the quality and defects of wood. This subject is treated of very fully in its various bearings; and with regard to the drying or desiccating process, which is a very important matter, as upon it rests nearly the whole question of commercial value, we have some facts, many of which, though not absolutely new, are worth recording, and should be well known to forest officers. Thus we are told (page 278) the proportion of water contained in wood varies according to the season. Schubler and Neuffler found in the fir (*Abies*) 53 per cent. in January and 61 in April; in the ash (*Fraxinus*), 29 per cent. in January and 39 in April. These facts prove that trees contain more water at the time of the ascent of the sap than in winter. Besides, it has been found that small branches contain more free water than large ones, and that these last contain more than the trunk, which results agree with the knowledge we possess of the porous nature of the different parts. The presence of the bark retards desiccation considerably.

Uhr having had some trees felled in June, after the ascent of the sap, and then having had them placed in the shade, found that those from which the bark had been removed had lost 34·53 per cent. of water in July, 38·77 in August, 39·34 in September, 32·62 in October; whilst those with the bark untouched had only lost during the same periods 0·41, 0·84, 0·92, 0·98. Thus it will be seen that the desiccation of barked wood proceeds much more rapidly. It is only stripped trunks of small size and soft wood that dry up with the rapidity above mentioned.

The numerous woodcuts dispersed throughout the book, and more especially those showing the defects of wood, are accurate representations of the subjects intended to be illustrated. A large portion of the book is devoted to the consideration of felling and cutting up timber, and of machinery used in its manipulation. J. R. J.

OUR BOOK SHELF

Zur lehre der Parallel-projection und der Flächen. Von Prof. Dr. Wilhelm Matzka. (Prag, 1874.)

Grundzüge einer Theorie der cubischen Involutionen. Von Dr. Emil Weyr. (Prag, 1874.)

THESE two reprints from the "Abhandlungen der k. böhm. Gesellschaft der Wissenschaften" are purely mathematical, as may be gathered from their titles. The author of the first treatise states that the *orthogonal* projection of broken lines on given axes, whether in a plane or in space, has been discussed in scientific works on theoretical and practical mathematics, but the *oblique* projection has not obtained so great prominence. The subject is gone into very thoroughly by Dr. Matzka, as may be inferred from the fact of its discussion occupying 70 quarto pages.

The work by Dr. Weyr needs only to be mentioned in these columns, as his exhaustive treatment of any subject he takes in hand, especially of a geometrical character, is well known—"Nihil tetigit, quod non ornavit." The treatise occupies 54 quarto pages.

Practical Hints on the Selection and Use of the Microscope. By John Phin. (The Industrial Publication Company, New York.)

THE contents of the small volume before us fully justify the wording of its title. On the other side of the Atlantic the system of puffing worthless optical instruments seems to be on a much greater scale than in this country. "To the young student whose means are limited, and to the country practitioner whose ability to supply himself with instruments often falls far short of his desires, the offer of a serviceable microscope for a couple of dollars is a great temptation, and when the instrument in question is endorsed by a long list of clergymen, lawyers, and even editors, this temptation becomes irresistible." To show what these worthless microscopes really are, and what ought to be expected of the most ordinary one, are the main objects the author has in view in the earlier pages of the work. Further on he explains the manner of using the instrument, and the method of mounting specimens for examination. Accurate formulæ are given for the preparation of a large number of preservative solutions, amongst which we do not find any sufficiently novel to deserve special mention. It is in the practical nature of its remarks, and not in their novelty, that the value of Mr. Phin's short book rests, and to the tyro it will be found to give information of real value. Beside Mr. R. B. Tolles, J. Grunow, J. Zentmayer, and W. Wales are mentioned as manufacturers of good objectives in the United States; and Mr. McAllister's stands are particularly praised.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Sleep of Flowers

IN your "Notes" (vol. xii. p. 484) you mention a recent paper by M. Royer on this little-understood class of phenomena. We are acquainted with the objects of most of the spontaneous and periodical movements of plants, but of the physiological means by which these same movements are effected we know little or nothing. But it is important to remember that phenomena like in effect may be diverse in cause. The folding up of petals may have nothing physiologically in common with that of foliage-leaves. In fact, these phenomena may be divided into several classes. Thus movements due to irritation or concussion must be considered apart from those due to spontaneity, and the movements which form part of the series of processes of growth, such as the first unfolding of leaves and flowers, from those which occur in mature organs, though movements belonging to any two of these classes may be exhibited by the same plant, as in Oxalis and Mimosa. *Cereus grandiflorus* opens between 7 and 8 P.M., *Mirabilis jalapa* between 5 and 7 P.M. There is every probability that these times are those at which the insects which fertilise these two species also come forth, and that the same object exists in the case of other species which open and close their flowers more than once, "waking" and "sleeping;" but in the case of Cereus and Mirabilis the movement is one of growth only, though, no doubt, affected by external influences, such as the variation of heat and light. We have, however, cases of true "sleep" in *Ipomœa nil* and *Calystegia sepium*, which open between 3 and 4 A.M.; *Tragopogon*, the ligulate florets of which behave like petals, and which, opening at the same time, closes again before noon; *Anagallis arvensis*, opening at 8 A.M. and closing when the sky is overcast; the Mesembryanthaceæ, which open generally about 12—*Mesembryanthemum noctiflorum*, which opens between 7 and 8 P.M., being an exception; and *Victoria regia*, which opens for the first time about 6 P.M., closes in a few hours, opens again at 6 A.M., and closes finally and sinks in the afternoon; and in many other cases. Besides the causes mentioned in your note, the movements have been attributed to actinism. That they are not hygrometric is clear from the fact stated by Sachs, on the authority of unpublished experiments by Pfeffer ("Text-book of Botany," p. 798), that they take place under water. These same experiments show them to be due to variations in the temperature, and when the temperature is constant, to variations in the intensity of light, and also to be accompanied, at least in some cases, with an increase of the length of the inner side of the phyllæ of the perianth when opening. Light certainly seems to have more to do with the movements of the "poor man's weather-glass" than heat, though perhaps atmospheric pressure might equally well be argued to be their cause. We must remember that as osmotic action is constantly going on at the root-hairs and in the growing parts of living plants, so a constant molecular diffusion of gases is going on through cell-walls, besides the passage of gases through stomata. "The movements of diffusion," as Sachs says (p. 614), "tend to bring about conditions of equilibrium which depend on the co-efficients of absorption of the gas by a particular cell-fluid, on the molecular condition of the cell-wall, &c., on temperature, and on the pressure of the air. But these conditions are continually varying, and the equilibrium continually disturbed." That a turgescence such as M. Royer describes occurs in many cases is well known. Space does not allow a detailed description of the physiological mechanism, but nearly all we yet know may be found in Sachs, who, however, attributes the phenomena directly solely to the passage of water and the elasticity of the cell-walls. Indirectly the cause may very possibly be heat acting as M. Royer supposes. It would be interesting to learn the effect of pollination on these plants, especially whether after it had taken place *Victoria regia* would re-open. G. S. BOULGER.

8, Westbury Road

Dehiscence of the Capsules of *Collomia*

IN Mr. Duthie's very interesting account (vol. xii. p. 494) of the mode of dehiscence of the capsules of this plant, he suggests that the purpose of the projection of the seeds on to the viscid hairs of the plant itself may possibly be found in its enabling the plant to live on its own seeds. Surely this is a superfluous and needlessly improbable hypothesis. The violent discharge of the seeds is undoubtedly one of the modes adopted by nature for their dispersion to plots of ground where the mineral constituents of the soil which they mainly require have not been entirely used up by the parent plant. Their interception by the parent plant is no doubt accidental. The purpose served by the viscid hairs of this and other plants still remains to be discovered if we follow the clue afforded by Mr. Darwin's observations on insectivorous plants. The violent expulsion of the seeds from the ripe capsule is a much more common phenomenon than that which we have exhibited in *Collomia*, together with a few other plants, as *Acanthus*, *Ruellia*, *Eschscholtzia*, and *Geranium*, where the whole fruit is thrown off together. Mr. Duthie will find a good description of the phenomenon in Hildebrand's "Die Schleuderfrüchte und ihr im anatomischen Bau begründeten Mechanismus," in Pringsheim's "Jahrbuch" for 1873–74. The author draws an interesting comparison between the structure of *Collomia*, with its single seed in each division, and its apparatus for projecting these to a distance, and that of the allied genus *Gilia*, with its numerous seeds in each division, which possess no such mechanism, but which, being much lighter, are consequently more easily dispersed by the wind.

ALFRED W. BENNETT

Oceanic Circulation

MR. CROLL'S statement (vol. xii. p. 494), that the North Atlantic in lat. 38° is above the level of the equator, is based partly on the *Challenger* soundings and partly on Muncke's determinations of the thermal expansion of sea-water, which, however, *were not made on sea-water at all*, but on a saline solution prepared for him by Leopold Gmelin, according to data furnished by the incomplete analyses of Vogel and Bouillon La Grange. As Mr. Croll's statement depends on such very minute differences of volume, I am led to ask him to compare the rate of expansion of *real* sea-water, as determined by Prof. Hubbard, with Muncke's table; he will notice a discrepancy sufficiently wide to make it a matter of interest to ascertain how far the employment of the American observations may serve to substantiate or modify his conclusion.

Yorkshire College of Science, Oct. 11 G. E. THORPE

High Waves with a North-west Wind

YOUR correspondent Capt. Kiddle has again called attention (vol. xi. p. 386) to the greater height of waves raised by a north-west wind, over those raised by a S.W. wind. I have observed the fact twice in the mid-Atlantic, but also very often on the west coast of Scotland, from which it is evident the phenomenon can be due to no particular combination of currents.

An examination of synoptic charts, for the dates of many cases, has convinced me that the phenomenon is due to the nature of the circulation of the air in a cyclone.

In the south-east portion of a cyclone, where S.W. winds are found, the wind seems to blow along and almost off the surface of the sea; while in the south-west portion, where N.W. winds are found, the wind seems to bear down on the sea, and "harrow" it into streaks of foam.

A perfectly analogous phenomenon appears in dust whirls, where to the right front of the centre the dust is closely packed, and tends to rise off the ground; while behind the centre the dust is "raked" into streaks by the more downward direction of the blast.

The portion of the Atlantic about 45° N. latitude, and between 40° and 50° W. longitude, where Capt. Kiddle has observed such high waves, has long been known as the "Roaring Forties." An examination of synoptic charts of the North Atlantic, for every day of the year 1865, shows that the bad weather in those parts is generally due to one of two conditions of the distribution of atmospheric pressure.

In the commoner case, the great area of high barometric pressure, which constantly covers the North Tropical Atlantic, stretches northwards to the east of Newfoundland like a wedge, on the east side of which cyclones are formed which go in an E. or N.E. direction.

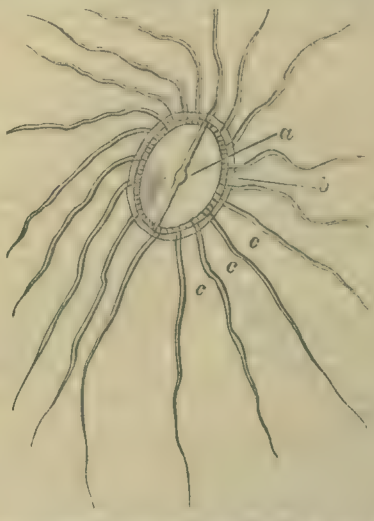
In the rarer but more violent case, the great Atlantic area of high pressure rises into two heads or humps, one about Madeira, the other about Bermuda, stretching up to Newfoundland. Cyclones coming from Labrador work round this hump to the S.E., and die out in mid-Atlantic. In either case gradients for N.W. winds, often very steep, are formed between the fortieth and fiftieth parallels of longitude. RALPH ABERCROMBY

21, Chapel Street, S.W., Oct. 1

Diatoms

I HAVE reason to think that I have made a discovery which may change the ideas of naturalists as to the nature of some *Diatoms*.

In collecting *Diatomaceæ* I have found a species of *Navicula* (?) which is invested with a gelatinous envelope, and from the edges of the frustule project a number of long processes or arms of the same soft nature. These vary much in number, in some specimens being eight or ten, and in others as many as twenty-five or even more. They are longer than the frustule, and radiate from it with much regularity. The Diatoms when detected (upon a floating *fucus* common in the sea hereabout) were dead, and I was unable to detect any movements.



a, the frustule: *b*, the gelatinous envelope projecting beyond the margin; *c c c*, the processes, or pseudopodia.

I have examined so many individuals of this *Diatom* that I think it hardly likely that I have been deceived, as they are by no means very minute.

Dr. Carpenter, in the fifth edition of his admirable work on the microscope, speaks of some observations by Mr. Stevenson on the genus *Coscinodiscus*, which hint at the possibility of some Diatoms having appendages projected through apertures of the frustule. The highest power of my microscope is one of Messrs. R. and J. Becks, $\frac{1}{8}$th, a very fine glass.

I propose to forward as soon as possible the sticks, dry and in balsam, as well as the "gathering" in spirits, to a competent diatomist, who will confirm my observations if correct, and I send this to NATURE to secure priority in case I have really made a discovery. W. W. WOOD

Manila, July 20

Tails of Rats and Mice

It is, I believe, pretty generally supposed that rats and mice use their tails for feeding purposes in cases where the food to be eaten is contained in vessels too narrow to admit the entire body of the animal. I am not aware, however, that the truth of this supposition has ever been actually tested by any trustworthy person, and so think that the following simple experiments are worth publishing

Having obtained a couple of tall-shaped preserve bottles with rather short and narrow necks, I filled them to within three inches of the top with red currant jelly which had only half stiffened. I covered the bottles with bladder in the ordinary way, and then stood them in a place frequented by rats. Next morning the bladder covering each of the bottles had a small hole gnawed through it, and the level of the jelly was reduced in both bottles to the same extent. Now, as this extent corresponded to about the length of a rat's tail if inserted at the hole in the bladder, and as this hole was not much more than just large enough to admit the root of this organ, I do not see that any further evidence is required to prove the manner in which the rats obtained the jelly, viz., by repeatedly introducing their tails into the viscid matter, and as repeatedly licking them clean.

However, to put the question quite beyond doubt, I refilled the bottles to the extent of half an inch above the jelly level left by the rats, and having placed a circle of moist paper upon each of the jelly surfaces, covered the bottles with bladder as before. I now left the bottles in a place where there were no rats or mice, until a good crop of mould had grown upon one of the moistened pieces of paper. The bottle containing this crop of mould I then transferred to the place where the rats were numerous. Next morning the bladder had again been eaten through at one edge, and upon the mould there were numerous and distinct tracings of the rats' tails, resembling marks made with the top of a penholder. These tracings were evidently caused by the animals sweeping their tails about in the fruitless endeavour to find a hole in the circle of paper which covered the jelly.
GEORGE J. ROMANES

Dunskaith, Ross shire

NEWCOMB ON THE URANIAN AND NEPTUNIAN SYSTEMS.

When the 26-inch equatorial, with an object-glass "nearly perfect in figure," was mounted at the United States Naval Observatory, Washington, it was resolved that its great powers should be first devoted to systematic observations of the satellites of the exterior planets, with the view not only to the better determination of the elements of their orbits, but, more especially, of the masses of their primaries; previous attempts in this direction, from the great difficulties attending observations, having led to very discordant values. Accordingly all the minor arrangements of the instrument were completed with this particular object in view, and no other regular work of dissimilar character was attempted while the satellite-observations were in progress.

In the memoir (Washington Observations, 1873, Appendix I.) to which allusion was made in this column last week, Professor Newcomb describes generally his method of observation; and with respect to his measures of the inner satellites of Uranus, which he thinks may fairly be regarded as the most difficult well-known objects in the heavens, he expresses surprise at the degree of precision with which he was able to bisect them with the faintly-illuminated wire of the micrometer, an examination of the individual measures having shown that they were not more discordant than those of the outer satellites.

In discussing the observations of the satellites of Uranus, extending from January 1874 to May 1875, circular elements are assumed for the formation of equations of condition, and by the usual methods elliptical orbits are obtained for each satellite; but it results that there is but slight evidence of any real excentricity of the orbits, and none whatever of any mutual inclination. Circular elements derived similarly are retained, and Tables for the ready prediction of the positions of the satellites which are most essential for their certain observation are founded upon them, and appended to Prof. Newcomb's memoir. The most probable mean plane of the orbits is found to have the following elements:—

Ascending node on earth's equator ...	165°·10 + 1°·43 (*t* − 1850)
Inclination	75·14 − 0·14 (*t* − 1850)

Or, as referred to the ecliptic,

Ascending node	165°·48 + 1°·40 (*t* − 1850)
Inclination	97·85 − 0·013 (*t* − 1850)

(The motion of the satellites of Uranus is direct upon the equator, but retrograde when referred to the ecliptic.)

Other elements are:—

	Mean Longitude	Radius of orbit.	Period of Revolution. Days
Ariel	21°·83 ...	13″·78 ...	2·52038
Umbriel ...	136°·52 ...	19″·20 ...	4·14418
Titania ...	229°·93 ...	31″·48 ...	8·70590
Oberon ...	154°·83 ...	42″·10 ...	13·46327

Mean noon at Washington, 1871, December 31, is taken for the epoch of mean longitude, which is reckoned from the point where the orbit intersects the plane parallel to the earth's equator and passing through the centre of the planet. The arc values of radii of orbits are for the distance [1·28310]. If we assume the mean solar parallax, 8″·875, and adopt Clarke's equatorial semi-diameter of the earth, we find from these values the following distances of the satellites from Uranus, expressed in English miles.

Ariel	118,100	Titania ...	269,800
Umbriel ...	164,550	Oberon ...	360,800

It may be mentioned that Sir W. Herschel's observations between the years 1787 and 1798 are brought to bear upon the determination of the periods of Oberon and Titania.

For reasons which are given, Prof. Newcomb thinks it "extremely improbable that the masses of the satellites exceed $\frac{1}{15000}$ of that of the planet," in which case the Uranocentric perturbations due to mutual action will be "incapable of detection with any instrumental means yet known." He mentions that, seen with the 26-inch telescope, the brighter satellites, Titania and Oberon, shine with about the brilliancy of a fourth magnitude star to a single unassisted eye.

We must not omit to state that the discovery of the inner satellites, Ariel and Umbriel, is distinctly assigned by Prof. Newcomb to Mr. Lassell; indeed, there appears every reason for believing that these excessively minute objects have not yet been recognised with any instruments except the Washington refractor and the reflectors which Mr. Lassell has constructed: the discovery of these satellites may be dated from the definitive announcement made by Mr. Lassell to the Royal Astronomical Society in November 1851. Prof. Newcomb remarks that "where any difficulty whatever is found in seeing the outer satellites," he would not hesitate to pronounce it impossible to see the inner ones, and thus it is not likely that the Bothkamp and other observations can have referred to the latter.

Though no systematic search was made for additional satellites, Prof. Newcomb believes "he may say with considerable certainty that no satellite within 2′ of the planet and outside of Oberon, having one-third the brilliancy of the latter, and therefore that none of Sir William Herschel's supposed outer satellites can have any real existence."

In the Washington refractor the planet has always presented a sea-green colour, no variations of tint being ever noticed. Markings upon the disc were not especially looked for, but if any had been visible they would hardly have escaped remark.

The observations of the satellite of Neptune are treated in a very similar manner to those of the satellites of Uranus. No certain amount of ellipticity is exhibited, and circular elements are accordingly used in the formation of tables for the prediction of the positions of the satellite. For the epoch 1873, December 31, Washington mean noon, the mean longitude of the satellite, reckoned from the intersection of the orbit with the plane parallel to the earth's equator, and passing through the centre of the planet, was 98°·96; the node on equator, 183°·03, and the inclination, 121°·7. The radius of the orbit at the mean distance of Neptune [1·47814] is found to be 16″·275, or 218,550 miles. The mean motion assumed at the commencement of the discussion was that founded upon the observations of Mr. Lassell (Hind, "Monthly Notices," vol. xv.), and does not appear to admit of any sensible correction. Prof. Newcomb thinks the motion of mean longitude is correct within 2° or 3° a century. The period of revolution of the satellite is 5·8769 days.

No trace of a second satellite of Neptune has ever been seen, though it has been looked for carefully on several occasions.

The conclusion to which Prof. Newcomb's investigations have led, "that the orbits of all the satellites of the two outer planets are less excentric than those of the planets of our system, and that, so far as observations have yet shown, they may be perfect circles," will appear a remarkable one.

We take this opportunity of presenting the elements of the orbits of Uranus and Neptune adopted in the Tables of Prof. Newcomb, as perhaps an acceptable addition to the preceding outline of his researches on the satellites of these planets. The values of the major axes here given are not those which would result from the mean motion with correction for the mass, but in the case of Uranus include a constant term in the perturbations of the radius vector, and in that of Neptune, constants introduced by the action of the planets, and effect of secular variation of the longitude of the epoch :—

	URANUS.	NEPTUNE.
Mean longitude, 1850 Jan. 0·0 G.M.T. ……	28° 25′ 17″·1	335° 5′ 38″·9
Longitude of perihelion ……	168 15 6·7	43 17 30·3
Ascending node ………… ..	73 14 8·0	130 7 31·9
Inclination …………………	0 46 20·5	1 47 0·6
Excentricity ……… . ………	0·0469236	0·0084962
Mean motion in the Julian year ……	15425″·75	7864″·935
Semi-axis major ……………	19·19130	30·07055
Period in days ………………	30686·63	60186·64

CASSOWARIES

LIKE the minor planets, Cassowaries are of late years continually increasing in number. A short time ago there was but one "Cassowary" recognised by naturalists, which was vaguely stated to inhabit "the Moluccas." Even Mr. Wallace's extensive researches in the Indian Archipelago only resulted in ascertaining the exact island to which the original *Casuarius galeatus* is restricted, without making us acquainted with other species. But recent expeditions into the less known parts of the Papuan sub-region have led to a much more extended knowledge of the subject, and we have now arrived at the conclusion that the genus *Casuarius* embraces a numerous group of species, each of which has special distinctive characters and a peculiar geographical distribution. Six of these forms of Cassowary are at the present time represented by specimens living in the Gardens of the Zoological Society of London, where they have attracted much attention. It is with the hope of obtaining further exact information concerning these fine birds from travellers in the countries which they inhabit that I have drawn up the following short summary of the present state of our knowledge of the different species.

The Cassowaries may be divided into three sections, as shown in the subjoined table :—

Table of Species of the Genus Casuarius.

a. Casside lateraliter compressa; appendicula cervicis aut duplici aut divisa.

1. *C. galeatus*, ex ins. Ceram.
2. *C. beccarii*, ex ins. Aroensi Wokan.
3. *C. australis*, ex Australia bor.
4. *C. bicarunculatus*, ex ins. Aroensibus.

b. Casside transversim compressa; appendicula cervicis unica.

5. *C. uniappendiculatus*, ex Papua.

c. Casside transversim compressa; appendicula cervicis nulla.

6. *C. papuanus*, ex Papua boreali.
7. *C. westermanni*, ex ins. Papuana Jobie (?).
8. *C. picticollis*, ex Papua meridionali.
9. *C. bennetti*, ex Nov. Britann.

The first of these sections contains the large species allied to the original *C. galeatus*. These have on their heads an elevated casque, laterally compressed and terminating in a ridge in the same line as the culmen of the bill. They have also a large fleshy caruncle on the front of the neck, ending in two distinct flaps. A single species, which stands somewhat alone and forms a second section, is also of large size, but has the casque transversely compressed and ending in a ridge at a right angle to the culmen. It has but one medial throat-wattle, whence it has been named *uniappendiculatus*. The third section embraces the smaller species allied to Bennett's Cassowary, or the Mooruk. These have the casque transversely compressed as in the one-wattled species, but have no wattle on the throat—only a bare, brightly coloured space. They are further distinguishable by the extraordinary form of the claw of the inner toe, which attains a remarkable length and is used as a weapon of attack. Of these three sections, the following nine species are now known with more or less certainty :—

1. THE COMMON CASSOWARY (*G. galeatus*), of which there is now no doubt that the island of Ceram is the true habitat. Of this species we have now one example, not yet adult, in the Zoological Society's Gardens.

2. BECCARI'S CASSOWARY (*C. beccarii*).—This form is closely allied to *C. galeatus*, but is easily distinguishable from it by having only one medial throat-wattle, which is slightly divided at the extremity. It has a large elevated casque like the Australian Cassowary, and remarkably large strong legs. The species was originally described by me from a specimen in the Museo Civico at Genoa, which was brought by Beccari from the Aroe Islands; but the living individual now in the Zoological Gardens (if it is really of the same species) was obtained in the south of New Guinea by H.M.S. *Basilisk*.

3. THE AUSTRALIAN CASSOWARY (*C. australis*).—Of this Cassowary, remarkable in the adult for its large size and highly elevated casque, we have now two specimens living in the Gardens. It is a native of Northern Queensland and the peninsula of Cape York.

4. THE TWO-WATTLED CASSOWARY (*C. bicarunculatus*).—This species, which is easily known, even in the young condition, by having the wattles separated and placed far apart on the sides of the neck, was first described from two examples, formerly living in the Zoological Gardens, but now dead. There are several stuffed specimens of it in the Leyden Museum, which were undoubtedly obtained in the Aroe Islands.

5. THE ONE-WATTLED CASSOWARY (*C. uniappendiculatus*).—The single small wattle which ornaments the middle of the neck at once distinguishes this fine species, of which we have now in the Gardens a young specimen brought by H.M.S. *Basilisk* from the coast on the north of New Guinea, opposite Salawatty. There is a good figure of this Cassowary in the supplement to Gould's "Birds of Australia."

6. THE PAPUAN CASSOWARY (*C. papuanus*).—This name has been given to two specimens in the Leyden Museum, obtained near Dorey, in New Guinea, by Rosen-

berg. Prof. Schlegel at first identified them with the Mooruk, but afterwards admitted their distinctness. My belief is that they are probably the same as the next species (*C. westermanni*), although the colours of the neck, as restored in the stuffed specimens, do not quite agree.

7. WESTERMAN'S CASSOWARY (*C. westermanni*).—This species I established on a bird still living in the Zoological Gardens, which we received from Mr. Westerman in 1871. At first I referred this bird to *C. kaupi*, of Rosenberg, until that naturalist showed that the pretended species which he had so named was nothing more than the young of *C. uniappendiculatus*. I then changed our bird's name to *C. westermanni*. I have recently seen two other living specimens of this bird in the Zoological Gardens at Rotterdam. It has been suggested that its true home is the island of Jobie, in the Bay of Geelvink, where Dr. Meyer ascertained the existence of a Cassowary, but was not able to procure specimens.

8. THE PAINTED-NECKED CASSOWARY (*C. picticollis*).—This species was likewise established by me on a specimen now living in the Zoological Gardens, which was obtained by the officers of H.M.S. *Basilisk* at Discovery Bay, on the east coast of New Guinea. It greatly resembles the Mooruk, but differs in its brilliantly-coloured neck, of which I have given a drawing in the P. Z. S. for the present year (1875, Part I.)

9. THE MOORUK, OR BENNETT'S CASSOWARY (*C. bennetti*).—In 1857 Mr. Gould described this Cassowary from a drawing sent to him by Dr. George Bennett, of Sydney, and soon afterwards a living pair were sent to us by our excellent friend, after whom the species had been named. These birds bred in the Gardens in 1864, but we have now unfortunately lost them. Bennett's Cassowary is an inhabitant of New Britain, to the east of New Guinea, and is easily distinguishable from its congeners by its blue throat and back of the neck.

Omitting for the moment the doubtful *C. papuanus*, it will be thus seen that we have tolerably certain indications of the districts in which the other eight Cassowaries are found. It would be very desirable, however, to get further information concerning them, and also to ascertain what is the Cassowary of Jobie, and whether the other islands adjacent to New Britain possess, as is probable, indigenous species of this group.

P. L. SCLATER

ANOTHER MONSTER REFRACTOR

THE experiment rendered possible, now some ten years ago, by Mr. Newall, and made with such triumphant success by Mr. Cooke, is again bearing fruit. Another monster telescope, indeed the largest yet attempted, is now in course of construction at Mr. Grubb's new works, near Dublin. This instrument has been ordered by the Imperial and Royal Austro-Hungarian Government for the new Observatory now in course of erection at Vienna. The object-glass will have an aperture of over 26 inches, probably about 27 inches, according as the discs of glass, which are being manufactured in the rough, by M. Feil, of Paris, may turn out on finishing. The focal length is to be about 32 feet. The general form of mounting will be modified to suit the special requirements of such a monster instrument. The great base casting (weighing some seven to eight tons) will form a chamber (about 12 feet long, 4 feet 6 inches wide, and 8 feet high) for the clock, which will be massive in proportion to the other parts. The axes will all have their friction relieved by anti-friction apparatus. The tube will be entirely of steel, and all the various motions of the instrument, as well as the reading of the different circles, will be available to the observer from the eye-end of the telescope.

A circular chamber of 45 feet diameter has been provided in Mr. Grubb's new workshops, to be covered for the present by a corrugated iron roof 50 feet high. In this the telescope is to be set up, and over this will be meanwhile erected an enormous steel dome, revolving on the system of rollers designed some years since by Mr. Thomas Grubb, and adopted at Dunsink Observatory, near Dublin, and at Lord Lindsay's Observatory. All of this dome and revolving machinery is afterwards to be removed to Vienna. Thus, by taking down the stationary iron roof, when the steel dome is erected over it, the equatorial will be placed in perfect working order, under its own roof in Dublin, for trial. It is proposed to attempt to illuminate the verniers and circles by Geissler's tubes. If M. Feil can, as he hopes, perfect the pair of discs required within twelve months, Mr. Grubb expects to have the whole instrument complete by the autumn of 1878, in which year, we may remark, it is not impossible that the British Association may be invited to Dublin. Should Lord Rosse's reflector be in order and the Vienna telescope complete, Section A will certainly muster in great force.

THE DIFFERENCE OF THERMAL ENERGY TRANSMITTED TO THE EARTH BY RADIATION FROM DIFFERENT PARTS OF THE SOLAR SURFACE

PÈRE SECCHI, in the second edition of "Le Soleil," published at Paris 1875, again calls attention to the result of his early investigations of the force of radiation emanating from different regions of the sun's surface, reiterating without modification his former opinions regarding the absorption of the radiant heat by the solar atmosphere. It will be well to bear in mind that the plan adopted by the Italian physicist in his original researches, on which his present opinion is based, was that of projecting the sun's image on a screen, and then, by means of thermopiles, measuring the temperature at different points. The serious defects inseparable from this method of measuring the intensity of the radiant heat I need not point out, nor will it be necessary to urge that a correct determination of the energy transmitted calls for direct observation of the temperature produced by the rays projected towards the earth. Accordingly, on taking up that branch of my investigations of radiant heat which relates to the difference of intensity transmitted from different parts of the sun's surface, I adopted the method of *direct* observation. The progress was slow at the beginning, owing to the necessity of constructing an astronomical apparatus of unusual dimensions, but having devised means which rendered the employment of any desirable focal length practicable, the work has progressed rapidly. An instrument of 17·7 metres (58 feet) focal length, erected to conduct preliminary experiments, has proved so satisfactory that the construction of one of 30 metres focal length, which I supposed to be necessary, has been dispensed with. Considering that the apparent diameter of the sun at a distance of 17·7 metres from the observer's eye is 162·4 millimetres even when the earth is in aphelion, the efficacy of the instrument employed might have been anticipated. The nature of the device will be readily comprehended by the following explanation:—Suppose a telescopic tube 17·7 metres long, 1 metre in diameter, devoid of object-glass and lenses, and mounted equatorially, to be closed at both ends by metallic plates or diaphragms, at right angles to the telescopic axis. Suppose the diaphragm at the upper end to be perforated with two circular apertures 200 millimetres in diameter, situated one above the other in the vertical line, 360 millimetres from centre to centre; and suppose a third circular perforation whose area is one-fifth of the apparent area of the solar disc, viz. 72·6 millimetres diameter, to be made on either side of the vertical line. Suppose, lastly, that the diaphragm which closes the lower end of the tube be perforated with three small apertures 6 millimetres in diameter, whose centres correspond exactly with the centres of the three large perforations in the upper diaphragm. The tube being then directed towards the sun, and actinometers applied below the three small apertures in the lower diaphragm, it will be evident that two of these instruments will, after due exposure to a clear sun, indicate maximum solar intensity, say 35° C., while the actinometer applied in line with the perforation whose area is one-fifth of the apparent area of the solar disc, will indicate $\frac{35}{5} = 7^\circ$ C., unless the central portion of the solar disc radiates more powerfully towards the earth than the rest, in which case a higher intensity than 7° C. will be indicated by the actinometer referred to. It will be readily understood that the solar rays entering through the perforations at the upper end of the tube, converge at the lower end and pass through the small perforations, causing maximum indication of the focal actinometers as stated. Now, suppose that a circular plate, the area of which is exactly ⅘ of the apparent area of the sun, viz. 145·2 millimetres diameter, be inserted concentrically in either of the two large perforations of the diaphragm at the top of the telescopic tube. The apparent diameter of the sun being as before stated 162·4 millimetres, it will be perceived that the inserted plate will only partially exclude the solar radiation, and that the rays from a zone 1′ 42″ wide will pass outside the said plate, converging in the form of a hollow cone at the lower end of the tube, and there enter the respective actinometer. The indication of the latter will then show the thermal energy transmitted by radiation from a zone whose mean·width extends 49″ from the sun's border. It should be particularly observed that the three focal actinometers employed will be acted upon *simultaneously* by the converged rays, (1) from the entire area of the solar disc, (2) from a *central* region containing ⅕ of the area, and (3) from a *zone* at the border containing also ⅕ of the area of the solar disc. It is scarcely necessary to point out that an accurate comparison of the intensity of the radiant heat emanating from the central part and from the sun's border calls for *simultaneous* observation, in order to avoid the errors resulting from change of zenith distance and variation of atmospheric absorption during the investigation. The great advantage of obtaining also a simultaneous indication of the intensity transmitted by radiation from the entire solar disc is self-evident, since this indication serves as an effectual check on the observed intensities emanating from the *centre* and from the *border*. The latter obviously must be less, while the former must be greater, for a given area, than the indication of the focal actinometer which receives the radiation of the entire solar disc.

FIG. 1.

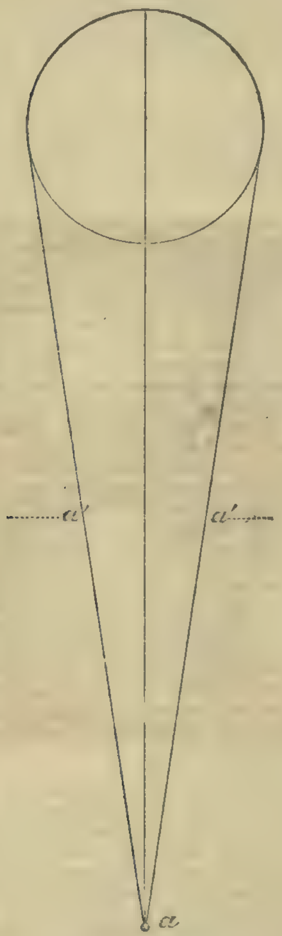


FIG. 2.

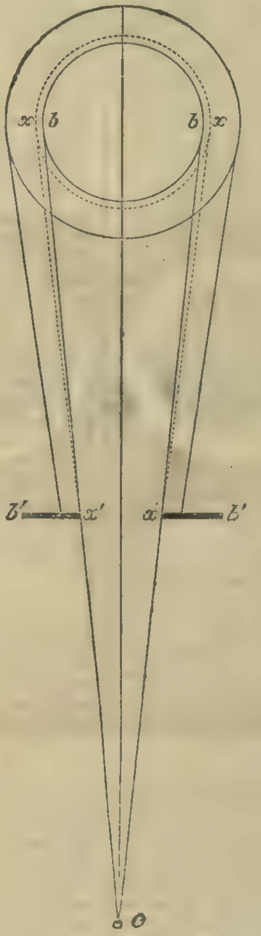
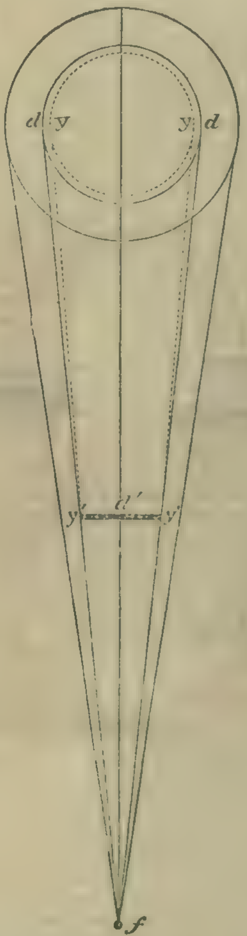


FIG. 3.



The foregoing demonstration, based on hypothesis, having established the possibility of ascertaining by direct observation the temperature produced by the rays projected from certain parts of the solar surface, let us now examine the means actually employed. An observer on the 40th deg. latitude, stationed on the north side of a building 28 metres high pointing east and west, can just see the sun pass the meridian, during the summer solstice, if he occupies a position about 8 metres from such building. Now, if an opaque screen perforated by a circular opening 313 millimetres in diameter be placed on the top of the supposed building, the entire solar disc may be seen through the same, provided it faces the sun at right angles. But if the perforation in the said screen be 140 millimetres in diameter, only ⅕ of the area of the solar disc will be seen. And if the screen be removed and a circular plate 280 millimetres in diameter put in its place, the observer, ranging himself in line with the plate and the sun's centre, can only see a narrow border 1′ 42″ of the solar disc. Obviously the screen placed on the top of the building might be perforated like the upper diaphragm of the supposed telescopic tube, and a plate resembling the lower diaphragm, secured by appropriate means near the ground, might be made to support the focal actinometers in such a manner that their axes pass through the centres of the perforations of the screen above the building. It is hardly necessary to state that the plate supporting the actinometers should be attached to some mechanism capable of imparting to it a parallactic movement, during the observation, corresponding with the sun's declination and the earth's diurnal motion; and, that some adequate mechanism should be employed for regulating the position of the perforated screen and adjusting the focal distance in accordance with the change of the subtended angle consequent on the varying distance from the sun. It will be evident that since the first-named mechanism rests on the ground, while the latter is secured to a massive building, far greater steadiness will be attained by our simple and comparatively inexpensive device, than by employing a telescopic tube of the most perfect construction mounted equatorially.

With reference to the influence of diffraction, it should be stated that before determining the size of the screens intended to shut out certain parts of the solar disc during the investigation, the amount of inflection of the sun's rays was carefully ascertained. Two distinct methods were adopted: (1) measuring the additional amount of heat transmitted to the focal thermometers in consequence of the inflection of the rays; (2) increasing the *theoretical* size of the screens until the effect of inflection was overcome and the luminous rays completely excluded. Regarding the first-named method of ascertaining the diffraction, it is important to mention that the temperature transmitted to the focal actinometers by the inflected radiation which passes outside of the theoretically determined screens is not proportionate to the inflection ascertained by the process of enlargement referred to. This circumstance at first rendered the investigation somewhat complicated, but it soon became evident that the discrepancy is caused by the comparatively small inflection of the *invisible* heat rays. It will be seen presently that the radiant heat which passes outside of the screens in consequence of diffraction is considerably less than that which would be transmitted to the focal actinometers if the calorific rays were subjected to an amount of inflection corresponding with the enlargement of the screens beyond the theoretical dimensions necessary to exclude the luminous rays.

Let us first consider the method of ascertaining the inflection of the rays by measuring the additional amount of heat transmitted to the focal actinometers. Fig. 1, see illustration, represents the solar disc, *a* being the focal actinometer exposed to the converged rays, *a' a'* representing an imaginary plane situated 17·7 metres from *a*, at which distance the section of the pencil of converging rays will be 162·4 millimetres in diameter, provided the earth is near aphelion. Fig. 2 also represents the solar disc, and *c* the actinometer exposed to the converged rays; but a perforated screen *b' b'* is interposed, the perforation being of such a size that only the rays projected by the central half of the solar disc (indicated by the circle *b b*) pass through the same and reach the focal actinometer. The screen *b' b'* being situated 17·7 metres from *c* when the earth is in the position before referred to, the said perforation must be 114·83 millimetres in diameter, in order that the lines *b x' c* may be straight. Fig. 3 likewise represents the solar disc, its area being divided in two concentric halves by the circle *d d*; but in place of a perforated screen, an opaque circular screen *d'* is introduced at the same distance from the focal actinometer as in Fig. 2; consequently the lines *d y' f* will be straight. Now, if the actinometers *a*, *c*, and *f* be exposed to the converged solar radiation *simultaneously and during an equal interval of time*, *c* and *f* receiving the heat from one half of the solar disc (the former from the central and the latter from the surrounding half), the temperatures of *c* and *f* added together should correspond exactly with the temperature transmitted from the entire solar disc to *a*. Observation, however, shows that the temperatures of *c* and *f* together is 0·091 greater than the temperature imparted to *a*. Hence an increase of temperature of nearly one-eleventh is produced by the inflection of the calorific rays, one-half being the result of the bending of the rays within the perforation of the screen *b' b'*, the other half resulting from the bending outside of the screen *d'*. The increment of temperature being thus known, the degree of inflection may be easily determined by drawing a circle *x x* round the circle *b b*, covering an additional area of $\frac{0\cdot091}{2} = 0\cdot0455$; and by inscribing a circle *y y* within *d d*, covering an area of 0·0455 less than the area of *d d*. It will be perceived on reflection that *x x' b* represents the angle of inflection of the calorific rays within the perforation of the screen *b' b'*, and that *d y' y* represents the angle of inflection outside of the screen *d'*. Demonstration shows that the former angle measures 14″·57, while the latter measures 14″·86, the mean being 14″·71. Having thus determined the inflection resulting from invisible radiation, let us now ascertain the inflection of the luminous rays. As before stated, the apparent diameter of the sun at a distance of 17·7 metres from a given point is 162·4 millimetres when the luminary is furthest from the earth. Now our investigation shows that a screen 167 millimetres in diameter hardly suffices to exclude the luminous rays; hence their inflection amounts to $\frac{167 - 162\cdot4}{2} = 2\cdot3$ millimetres at a distance of 17·7 metres. Their angle of inflection will therefore be 26″·81, against 14″·71 for the dark rays. We have thus incidentally established the fact that the inflection of the luminous and calorific rays differs nearly in the same proportion as the calorific energies of the visible and invisible portions of the solar spectrum.

FIG. 4.

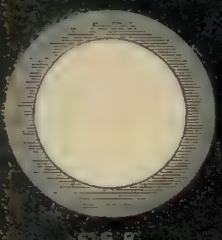


FIG. 5.

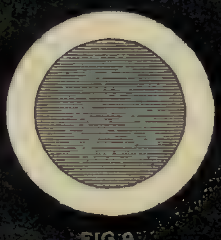


FIG. 6.

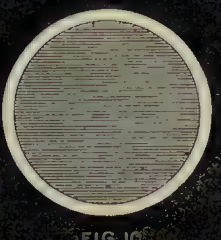


FIG. 7.

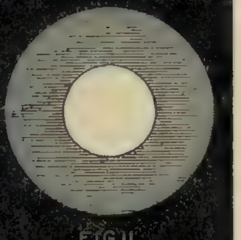


FIG. 8.

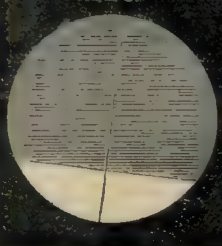


FIG. 9.

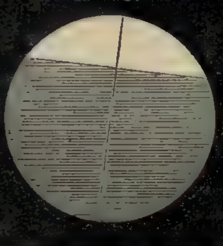


FIG. 10.

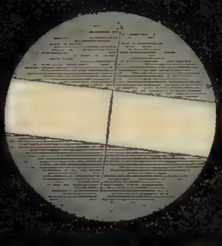
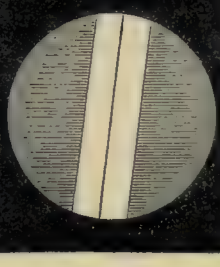


FIG. 11.



Our space not admitting of a detailed account of the result of the investigation, the leading points only will be presented. The observations have all been made at noon, the duration of the exposure to the sun having been limited to seven minutes, during which period the actinometers are moved, by the parallactic mechanism, through a distance of about 55 centimetres, from west to east. The intensity of the radiant heat imparted to the actinometers has been recorded by the observers at the termination of the fourth, fifth, sixth, and seventh minute, the exact moment for reading off being indicated by a chronograph. The relative intensities transmitted by radiation from the centre and from the border of the solar disc, first claim our attention. Fig. 6 represents the solar disc covered by a circular screen 145·25 millimetres in diameter, excluding the rays excepting from a narrow zone, the mean width of which is situated 49″ from the border of the photosphere. Fig. 7 shows a screen excluding the solar rays excepting from the central portion, *the area of which is precisely equal to the area of the narrow zone in* Fig. 6. The following table shows the intensities transmitted to the actinometers during an observation, August 25, 1875, the radiation from the solar disc being then excluded in the manner shown in Figs. 6 and 7:—

Time.	Central portion. Cent.	Border. Cent.	Rate of difference.
4′	3°·28	2°·19	$\frac{2·19}{3·28} = 0·667$
5′	3°·56	2°·37	$\frac{2·37}{3·56} = 0·665$
6′	3°·73	2°·49	$\frac{2·49}{3·73} = 0·667$
7′	3°·88	2°·60	$\frac{2·60}{3·88} = 0·669$
			Mean = 0·667

It should be particularly observed that this table records the result of four distinct observations; nor should it be overlooked that although the intensities vary greatly for each observation in consequence of the continued exposure to the sun, yet the rates showing the difference of the intensity of the rays transmitted from the border, inserted in the last column, is practically the same for each observation, the discrepancy between the highest and the lowest rate being only 0·004.* Persons practically acquainted with the difficulty of ascertaining the intensity of solar radiation will be surprised at the exactness and consistency of the indications of our actinometers. This desirable exactness has been attained by surrounding the actinometers with water-jackets, which communicate with each other by connecting pipes, through which a steady stream of water is circulated. By this expedient the chambers containing the bulbs of the several thermometers are maintained with critical nicety at equal temperature, an inexorable condition when the object is to determine differential temperature with great exactness. Apart from this, the chambers which contain the bulbs of the thermometers are air-tight, the radiant heat being admitted through a small aperture at the top of the chamber, covered by a thin crystal.

Referring to the preceding table, it will be seen that the intensity transmitted by radiation from the sun's border, represented in Fig. 6, is 0·667 of the intensity transmitted from the central region represented in Fig. 7, the area of each being precisely alike. From the stated intensity must be deducted the heat imparted to the actinometer by the inflection of the calorific rays. The circumference of the perforation of the screen shown in Fig. 7 being exactly one-half of the circumference of the screen in Fig. 6, while the central region radiates more powerfully than the border, fully one-half of the inflected radiation from the border will be balanced by the inflected radiation emanating from the central region. Agreeable to the previous demonstration relating to Figs. 2 and 3, it will be seen that the unbalanced inflection amounts to 0·029; hence the radiation transmitted from the border zone will be 0·667 − 0·029 = 0·638 of the intensity of radiation transmitted from the central region. We have thus shown by a reliable method that the intensity of the rays directed towards the earth from the border zone suffers a diminution of 1·000 − 0·638 = 0·362 of the intensity of the radiation emanating from the central region. But the mean depth of the solar atmosphere of the border zone, in the direction of the earth, is 2·551 greater than the vertical depth, while the mean depth over the central region referred to is only 0·036 greater than the vertical depth of the solar atmosphere. Consequently, if we accept the assumption that the retardation is as the depth, the absorption by the solar atmosphere cannot exceed $\frac{0·362}{2·551 - 0·036} = 0·144$ of the radiant heat emanating from the photosphere.* It will be found, on referring to the revised edition of "Le Soleil," vol. i. p. 212, that Père Secchi makes the following statements regarding the absorptive power of the solar atmosphere. (1) "At the centre of the disc, that is to say perpendicularly to the surface of the photosphere, the absorption arrests about $\frac{2}{3}$ or more exactly $\frac{62}{100}$ of the total force." (2) "The total action of the absorbing envelope on the hemisphere visible from the sun is so great that it allows only $\frac{12}{100}$ of the total radiation to pass, the remainder, namely, $\frac{88}{100}$, being absorbed." It is unnecessary to criticise these figures presented by the Roman astronomer, as a cursory inspection of our table and diagrams is sufficient to show the fallacy of his computations. Apart from determining the absorptive power of the solar atmosphere, the most important problem which may be solved by accurately measuring the intensity of the radiation emanating from various parts of the disc, is that relating to the sun's emissive power in different directions. In order to decide this question, I have adopted the plan of measuring the energy of the radiant heat transmitted from zones crossing the solar disc at right angles, as shown in Figs. 10 and 11. Should it be found that our actinometers are equally affected by the radiation from these zones, each of which occupies an arc of 30 deg. containing one-third of the area of the disc, the inference will be irresistible that the sun emits heat of equal intensity in all directions. It should be borne in mind that, agreeable to our method, the radiations from these zones are observed simultaneously. The arrangement exhibited in Figs. 10 and 11 hardly needs explanation. Referring to Fig. 10, it will be seen that two segmental screens are employed excluding the radiant heat, excepting from the zone, which is parallel with the sun's equator. Similar screens are employed (see Fig. 11) for excluding the rays excepting from the zone parallel with the sun's polar axis. The curvatures of the segmental screens, it should be observed, have been struck to a radius of ninety millimetres, in order to cut off effectually the inflected radiation from the sun's border. Obviously diffraction has not called for any correction of our observations relating to this part of the investigation, since the inflected radiation from the equatorial zone exactly balances the inflected radiation from the polar zone. It only remains to be stated that repeated observations show that the radiant energies transmitted to the actinometers from the two zones are identical. The result of observations relating to the radiation emanating from the polar regions, represented in Figs. 8 and 9, together with other observations, will be discussed in future communications.

J. ERICSSON

SOME LECTURE NOTES ON METEORITES†

III.

AMONG the mineral constituents of meteorites the unstable sulphides, it is hardly necessary to observe, could with difficulty be conceived as continuing permanently undecomposed, or as being even formed under the ordinary conditions of rock formation on our globe; and the same remark may be extended, though with some limitation, to the metallic iron that is so characteristic and ubiquitous a constituent of almost every, if, indeed, not (as maintained by Dr. Lawrence Smith) of every meteorite. On the other hand, it is to be remembered that the rocks that we are acquainted with on our globe are only those composing its outer crust; rocks which represent the results of the corrosive action of the atmospheric agencies, oxygen, carbonic acid, and water, and their counterpart the ocean, on whatever material the consolidated surface of our planet offered for their action. The endless cycle of mechanical and chemical disintegration, decomposition, and reconstruction would be limited to a shallow shell, and even the fresh matter forced out to the surface in volcanoes, through the contraction of the cooling globe, would consist in all likelihood only of the lower-lying layers of an already to a certain degree metamorphosed material. Whether the inner core of this planet is still in the meteoric condition—that is to say, still may contain such minerals as native iron, associated with nickel, not to say magnesium or calcium sulphides, is a question not to be lost sight of in explaining the high specific gravity of our globe as compared with that of the rocks that form its crust.

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* All my instruments for measuring radiant heat have been graduated to the Fahrenheit scale, which practically is more exact than the Centigrade, owing to its finer divisions. For the benefit of the Continental readers of NATURE, and in order to satisfy English and American advocates of the course Centigrade, the observed temperatures have been reduced to that cale before being entered in our tables.

* In the first edition of "Le Soleil," p. 264, the author assumes that the absorption of the calorific rays by the atmosphere "augments in proportion to the secant of the zenith distance;" in other words, as the depth of the atmosphere penetrated by the rays.

† Concluded from p. 507.

That the silicates contained in meteorites should be identical, or nearly so, with corresponding minerals in our globe seems only the natural consequence of the identity in the elements that constitute both. They are essentially magnesium silicates—namely, olivine the basic, and enstatite (or bronzite) the neutral silicate, the latter taking the form of augite to an amount corresponding to the calcium present, where this latter element is a constituent of the meteorite. Where, at the first production of the meteoric minerals by the union of their elements, the oxygen was in sufficient amount to allow of a portion of the iron present being in the state of an oxide, ferrous oxide is combined in the silicate, and the meteoric olivines are from this cause generally ferriferous, and the enstatite also assumes one of the varieties of that mineral which the mineralogist has termed bronzite. The silicic acid is rarely in excess of the amount requisite to form an enstatite or augite; usually the contrary condition is evidenced by the presence of some olivine. The case of the occurrence of free silica in the Breitenbach meteorite, at present exceptional, may, however, hereafter prove to be characteristic of a type, and its occurrence, not as quartz, nor even as tridymite (the crystallised silica discovered by von Rath), but in the form to which I gave the name asmanite, in crystals belonging to the orthorhombic system with the specific gravity of fused quartz, seems to point to conditions, probably involving an enormous temperature, as those under which such meteorites have been formed, and such as have not been realised in the production of any of the acid or super-siliceous silicates of our globe. The felspathic ingredients of meteorites are for the most part basic, chiefly consisting of anorthite, the most basic of terrestrial felspars, known as a crystallised mineral in volcanic rocks. Crystals of meteoric anorthite were measured by Viktor von Lang at the British Museum, with results quite concordant with those yielded by the crystals from the volcanoes of our planet. A felspar with a composition corresponding to that of labradorite, on the other hand, in the only meteorite in which its presence has been established beyond doubt, is proved by Tschermak to crystallise in the cubic system, instead of the anorthic system to which terrestrial labradorite belongs.

Attempts have been made to classify meteorites according to their mineralogical constitution. As a provisional method, such a classification has its uses; but while we find that the same meteorite may contain distinct portions which severally would authorise its being placed in different classes, such a classification must necessarily be very imperfect.

The best general divisions are those of Gustav Rose; and in the following table are classed the various groups of Aërolites, with a statement of the minerals that are met with in them:—

Aerolites.

CHONDRITIC	Olivine. Bronzite. Augite. Nickel-Iron. Troilite.
EUKRITIC...	Augite. Anorthite. Nickel-Iron.
CHLADNITIC	Bronzite or Enstatite. Augite (occasional). Nickel-Iron. Troilite Oldhamite (occasional). Osbornite. Chromite.
CHASSIGNITIC... ...	Olivine. Chromite.
CARBONACEOUS ...	Olivine. Enstatite. Nickel-Iron. Sulphur. Carbon. Troilite. Chromite. Hydrocarbons.

The great division of meteorites into iron masses or siderites, mixed masses or siderolites (the pallasites and mesosiderites of Rose), and aërolites or stony meteorites; and the sub-division of the latter into chondritic and non-chondritic varieties, seems to be a sufficiently logical division. And among the non-chondritic aërolites, those designated in Gustav Rose's classification as Eukrites form one well-marked group. They consist of anorthite mingled sometimes with augite in a crystallogranular admixture, with nickel-iron, troilite, magnetic pyrites, a little olivine, and small amounts of other minerals. The crystals of anorthite and the augite in the eukritic meteorite of Juvinas have afforded satisfactory goniometrical measurements, and been identified as regards their crystalline forms—the former, as before mentioned by V. von Lang, and the augite by Gustav Rose—with the corresponding terrestrial minerals; and it is the eukritic aërolites which most closely resemble some of our volcanic rocks.

The carbonaceous meteorites form another remarkable though not a distinct group. In these we meet with minerals which, if occurring in a terrestrial rock, would lead us to ascribe to that rock an igneous origin; they are the same minerals that occur in other meteorites (olivine, enstatite, &c.), but are associated with carbon and with a minute amount of a white or a yellowish crystallisable matter, soluble in ether and partly so in alcohol, and exhibiting the characters and the composition of one or more hydrocarbonous bodies with high melting points. Such an ingredient permeating a rock on our globe would assuredly be accepted as a product resulting indirectly from animal or vegetable existence. We must be cautious, however, in the extending of this generalisation to celestial hydrocarbons. It seems not at all improbable that this singular ingredient of these otherwise stony and fire-formed meteoric rocks may have been taken up by the mass subsequently to its formation; perhaps while passing through an atmosphere of these hydrocarbonous substances in the form of a vapour. The probability of this is enhanced by the smallness in the amount (about 0·25 per cent. only) of the white soluble bodies contained in the aërolite, and by the fact that the whole of it may be dissolved out from a mass of considerable size by the direct treatment of the solid aërolite by the boiling solvent, even without previous pulverisation; the substance, in short, mechanically fills the pores of the aërolite, but does not appear to be otherwise contained or entangled in the interior of the silicates or of the compacter aggregations of these within the meteorite.

The remaining divisions into which aërolites have been grouped are less distinctly marked, and their boundaries less fixed than those we have considered. In fact, a more comprehensive knowledge of all the varieties of meteorites and the modes in which their constituent minerals may be associated is needed for our forming a complete classification of them, and it is only necessary to make one observation in order to indicate the importance of our being able thus to arrange together these meteorites which are strictly comparable, and may be supposed to have had a common or at least a similar origin and history.

Such a classification is in fact a necessary preliminary to our ever successfully dealing with the problem of the periodically recurrent visitation to our earth of any particular class or group of meteorites. And it is here that the great collections of meteorites brought together in the National European Museums already are, and promise in a far higher degree in the future to be, so valuable. They offer the opportunities for the most complete comparison and the widest induction that our limited material admits of.

It may thus be possible hereafter by their aid to trace such a periodicity in the falls of meteorites of particular kinds as has been established in the cases of several meteor showers; or again the accumulation of observations recording the directions from which these bodies fall to the earth may enable us to connect those of a particular class with some definite direction that may indicate for these a common source in space. It may be feared, however, that owing to the species of refraction which their paths must undergo on entering the atmosphere, and the great difficulty, if not impossibility, of obtaining very accurate comparable parallactic observations of their paths, it will be impossible to rely on any calculated elements of their orbits before approaching our planet.

One of the difficulties confronting us in any endeavour to trace them to their sources, lies in the near similarity of composition of very large groups of them, such for instance as the entire group of the chondritic aërolites, or again that of the siderites, a similarity so close in each case as to render it difficult at first to suppose that the masses belonging to either of these groups originated under dissimilar conditions, or in widely sundered regions of space.

A difficulty of a similar kind further presents itself in the relative importance of nickel as an ingredient in the iron element of meteorites. One cannot indeed institute a comparison in this respect with the iron of our globe, which cannot be said to exist within the scope of our knowledge in the native state, while on the other hand the silicates composing meteorites, and those constituting the mass of our terrestrial rocks, are alike almost devoid of nickel; and a process that would reduce the iron in such rocks (*e.g.* serpentine or lherzolite) as contain traces of this element would simultaneously reduce the nickel also to the metallic condition, as has been shown by Daubrée.

Among those who have sought to throw light on the part of our problem which deals with the chemical history of meteorites, M. Daubrée, the distinguished Director of the Ecole des Mines, stands forward. He has subjected both meteorites and certain terrestrial rocks in some respects mineralogically allied to them to fusion under special conditions. He has, further, reviewed in a valuable article in the *Comptes Rendus* of the French Academy, the two opposite chemical conditions under which aërolitic matter may be supposed to have assumed its present form; those namely, first, of the oxidation with a limited supply of oxygen of the elements composing a meteorite assumed as combined *inter se*; and secondly, a condition under which a basic ferruginous silicate may be supposed to be converted into a neutral silicate with the emancipation of free iron by the operation of reducing agents, such as hydrogen or carbon, acting on the ferrous silicate at a high temperature.

In this way an olivine, rich in diferrous silicate, would become a bronzite poor in ferrous silicate, or become an enstatite without any iron in it at all, the iron lost in either case by the olivine being separated as metallic iron; and M. Daubrée performed transformations of this kind.

Now, the remarkable discovery by the late Prof. Graham of hydrogen in the Lenarto iron, and that recently made by Wöhler of carbonic oxide in the iron of Ovifak (due, however, probably in this case to the action of magnetic iron-oxide on the carbon of the meteorite), and also by Prof. Mallet of the same gas in a meteoric iron from Virginia, lend some probability to the view of M. Daubrée.

Still the existence of great masses of siderolites like those of Pallas and from Atacama, rich in ferruginous olivine, and presenting, so far as the analyses may be trusted, no trace of enstatite, or even bronzite, offers a great obstacle to the view that the iron in these cases was the result of a reduction from olivine. So again the Breitenbach siderolite, notwithstanding its large ingredient of free silica (as asmanite) consists largely of a bronzite very rich in ferrous monosilicate. This bronzite, however, it is to be said, resists the reducing action of hydrogen at a considerable temperature.

The similarity, not to say the peculiarity, as well in their chemical nature as in their mechanical condition that I have alluded to as characterising so many meteorites would seem to impose some restrictions on our freedom in tracing the origin of these bodies to distant and dissevered regions of interstellar space. And, indeed, though a great unity and simplicity in condition and in material would seem to rule throughout the stellar universe, as viewed by our present means of knowledge, and so far would justify our treating lightly the sameness of the meteoric material that reaches us as a check on our reasonings; yet it is to be borne in mind that the prism has only begun to interpret for us the language of the stars, and that further research may introduce complexity, and narrow the limits of our problem. On the other hand, we can only reason legitimately from the standing-point of the present; and it is equally probable, nay, almost certain, that the stellar spectra, in which, for instance, the lines characterising nickel have not yet been found, will, on direct search for them, yield those lines, and then the arguments otherwise converging on the probability of meteorites coming to us from interstellar space will acquire an almost conclusive character; for the difficulties in the way of our confining their origin to our own solar system are almost insuperable. Their high proper velocity, often far greater than that of the earth in her orbit, the directions of their motion, sometimes direct, often retrograde, and continually at high angles to the ecliptic, are not consistent with their being portions of asteroidal matter sporadically dispersed, while they are still less so with any explanation of meteorites as resulting from lunar volcanoes or from any lost telluric satellite, or from satellitic matter that had escaped the centralising influence of gravitation.

Whether any of the meteorites are intercepted by our earth while passing nodes common to our orbit, and to long cometary orbits described by innumerable meteoric groups around the sun, is a question we cannot answer in the present condition of our knowledge.

But reasoning by analogy from the movements of the meteor-swarms that we are acquainted with, this is rendered highly probable by the identification beyond a question of the orbits of periodic meteor-swarms with those of known comets, and the statement of Leverrier that these meteor-swarms are probably vast cosmical clouds consisting of sparsely-spread particles; and that some of them entering our solar system from interstellar space have been drawn aside by planetary attraction, and have assumed a circum-solar orbit. When the curve is an ellipse, they of course remain in our system, and are seen now as comets, or also again in certain very rare instances, where their orbit intersects with our own, as star-showers, which recur annually, or at the long intervals separating their approach to their perihelia, according as they have or have not been long enough members of our system for the meteoric dust to have become more or less equally distributed along their orbit in a ring, or have still only the form of a prolonged cloud continually becoming more and more annular in the distribution of its ingredient particles.

Four cases of unquestionable accordance between comets and meteor showers are established in—

The Lyriad meteoric shower (April 20–21) and Comet I. of 1861 (Galle and Weiss).

The Perseids meteoric shower (August 10–11) and Comet III. of 1862 (Schiaparelli).

The Leonids meteoric shower (November 13–14) and Comet I. of 1866 (Oppolzer, Peters, and Schiaparelli).

The Andromedes meteoric shower (November 27–28) and Biela's Comet (Galle and Weiss).

If we imagine meteorites to have a similar history, but with the difference that the meteor-particles are assembled into larger masses or clusters of them, and that these consequently are separated from each other by far vaster distances than is the case with the even widely-spread units that compose a meteor-swarm, we may comprehend why the meteorite is such a rare visitant as compared with the meteors proper, of which thousands must pass into our atmosphere every hour. Indeed, when we consider what has been before alluded to, touching the comparatively loose condition of aggregation of so many meteorites, and when we remember that the fine dust and little particles of a meteoric cloud are separated by no such atmosphere, gaseous or vaporous, as prevents actual contact between surfaces on a terraqueous globe, we may perhaps go so far as to suppose that if groups of the individual particular units of a meteor cloud once should approach each other to a distance small enough to give their mutual gravitation a sensible influence, they might gradually collect into masses, and acquire a cohesion more or less compact according to the conditions imposed on such masses during their subsequent history. Such is possibly the case with the nuclei of the comets, which would thus possess the character of a cluster of meteorites, while the coma is composed of meteoritic particles of the character of ordinary meteors.

There is one respect in which the comparison of the smaller meteors with those of greater magnitude and with meteorites may seem to point to a difference of some importance in the character of the objects themselves. The velocities usually ascribed to the former class of bodies are in many cases very much higher than that belonging to the larger objects. Thus, a velocity of 140 miles per second has been ascribed to some of the smaller meteors. Mr. Hind, however, gives the perihelion velocity of the August swarm at 26 miles per second, which, added to the motion of the earth (as the meteors are retrograde), would give a velocity of about 40 miles at a point so near their perihelion as that in which our earth meets them. On the other hand, a velocity of from 13 to 40 miles per second is that usually ascribed to the larger meteoric masses, and to meteorites of which the actual fall has been witnessed.

Furthermore, we have to consider, on the one hand, the very great difficulty in determining the parallax of a body moving so rapidly in the absence of accurate instrumental means of observing it, and on the other hand, the fact that a large meteoric mass is sure to be observed best, and by daylight almost exclusively, during the more brilliant and imposing, and therefore the nearer and more slowly traversed, portion of its track. Thus the small particles represented by the ordinary meteor are kindled and extinguished almost instantaneously in the upper part of the atmosphere, while the meteoroid masses of larger volume are observed and reasoned upon almost entirely during the more imposing part of their course, namely, their passage through its lower and denser regions.

While, then, we are restrained by the facts, as they at present stand, from separating into different classes of cosmical phenomena the meteors and the meteoroid bodies known as fireballs and meteorites, and I must add the comets, so are we constrained to recognise for all of these bodies—whether on encountering the earth they had become actually members of the solar family or not—an ultimately extra-solar origin; that, in fact, whether they, some or all of them, had become temporarily or permanently imprisoned, as it were, in the vortex of solar attraction, the probability is that they originally entered our system from the interstellar spaces beyond it. And it may further be said, that the tendency of scientific conviction is in the direction of recognising the collection towards and concentration in definite centres of the matter of the universe, as a cosmical law, rather than the opposite supposition of such centres being the sources whence matter is dispersed into space.

In the meteorites that fall on our earth (certainly in considerable numbers) we have to acknowledge the evidence of a vast and perpetual movement in space of matter otherwise unseen, about which we can only reason as part of a great feature in the universe, which we have every ground for not supposing to be confined within the limits of the solar system.

That this matter, whether intercepted or not by the planets and the sun, should to an ever-increasing amount become entangled in the web of solar and planetary attraction, and that the same operation should be collecting round other stars and in distant systems, such moving clouds of meteoric particles as have been treated by Schiaparelli, Leverrier, and other astronomers, whether as individuals or in clusters widely separated, of wandering stone or iron, is a necessary deduction from the view that we have assumed regarding the tendency of cosmical matter to collect towards centres.

But in order to trace the previous stages of the history of any meteorite, and in particular to determine the conditions under which its present constitution as a rock took its origin, we have only for our guide the actual record written on the meteoric mass itself; and it is in this direction that the mineralogist is now working.

But the process is necessarily a gradual one. We may indeed assert that the meteorites we know have, probably all of them, been originally formed under conditions from which the presence of water or of free oxygen to the amount requisite to oxidise entirely the elements present were excluded; for this is proved by the nature of the minerals constituting the meteorites, and by the way in which the metallic iron is distributed through them.

The progress of solar physics and the reflex light it is likely to shed on the condition of the primeval chaos of nebular matter, and the stages by which suns and planets were evolved, will no doubt help to explain the origin of meteorites; and possibly they in turn will be found to offer some not unimportant evidence on those cosmogenic questions which still belong to the more speculative region of Science.

N. S. MASKELYNE

A CITY OF HEALTH.*

IT is my object to put forward a theoretical outline of a community so circumstanced and so maintained by the exercise of its own free will, guided by scientific knowledge, that in it the perfection of sanitary results will be approached, if not actually realised, in the co-existence of the lowest possible general mortality with the highest possible individual longevity. I shall try to show a working community in which death, if I may apply so common and expressive a phrase on so solemn a subject—in which death is kept as nearly as possible in its proper or natural place in the scheme of life.

Before I proceed to this task, it is right I should ask of the past what hope there is of any such advancement of human progress. For as my Lord of Verulam quaintly teaches, "The past ever deserves that men should stand upon it for awhile to see which way they should go, but when they have made up their minds they should hesitate no longer, but proceed with cheerfulness." For a moment, then, we will stand on the past.

From this vantage-ground we gather the fact, that onward with the simple progress of true civilisation the value of life has increased. Ere yet the words "Sanitary Science" had been written; ere yet the heralds of that science, some of whom, in the persons of our illustrious colleagues Edwin Chadwick and William Farr, are with us in this place at this moment; ere yet these heralds had summoned the world to answer for its profligacy of life, the health and strength of mankind was undergoing improvement. One or two striking facts must be sufficient in the brief space at my disposal to demonstrate this truth. In England, from 1790 to 1810, Heberden calculated that the general mortality diminished one-fourth. In France, during the same period, the same favourable returns were made. The deaths in France, Berard calculated, were 1 in 30 in the year 1780, and during the eight years from 1817 to 1828, 1 in 40, or a fourth less. In 1780, out of 100 new-born infants in France, 50 died in the two first years; in the later period, extending from the time of the census that was taken in 1817 to 1827, only 38 of the same age died, an augmentation of infant life equal to 25 per cent. In 1780 as many as 55 per cent. died before reaching the age of ten years; in the later period 43, or about a fifth less. In 1780 only 21 persons per cent. attained the age of 50 years; in the later period 32, or eleven more, reached that term. In 1780 but 15 persons per cent. arrived at 60 years; in the later period 24 arrived at that age.

Side by side with these facts of the statist we detect other facts which show that in the progress of civilisation the actual organic strength and build of the man and woman increases. Just as in the highest developments of the fine arts the sculptor and painter place before us the finest imaginative types of strength, grace, and beauty, so the silent artist, civilisation, approaches nearer and nearer to perfection, and by evolution of form and mind develops what is practically a new order of physical and mental build. Peron—who first used, if he did not invent, the little instrument the dynamometer, or muscular strength measurer—subjected specimens of different stages of civilisation to the test of his gauge, and discovered that the strength of the limbs of the natives of Van Dieman's Land and New Holland was as 50 degrees of power, while that of the Frenchmen was 69, and of the Englishmen 71. The same order of facts are maintained in respect to the size of body. The stalwart Englishman of to-day can neither get into the armour nor be placed in the sarcophagus of those sons of men who were accounted the heroes of the infantile life of the human world.

We discover, moreover, from our view of the past, that the developments of tenacity of life and of vital power have been comparatively rapid in their course when they have once commenced. There is nothing discoverable to us that would lead to the conception of a human civilisation extending back over two hundred generations; and when in these generations we survey the actual effect of civilisation—so fragmentary, and overshadowed by persistent barbarism—in influencing disease and mortality, we are reduced to the observation of at most twelve generations, including our own, engaged indirectly or directly in the work of sanitary progress. During this comparatively brief period, the labour of which, until within a century, has had no systematic direction, the changes for good that have been effected are amongst the most startling of historical facts. Pestilences which decimated populations, and which, like the great plague of London, destroyed 7,165 people in a single week, have lost their virulence; gaol fever has disappeared, and our gaols, once each a plague-spot, have become, by a strange perversion of civilisation, the health spots of, at least, one kingdom. The term Black Death is heard no more; and ague, from which the London physician once made a fortune, is now a rare tax even on the skill of the hard-worked Union Medical Officer.

From the study of the past we are warranted, then, in assuming that civilisation, unaided by special scientific knowledge, reduces disease and lessens mortality, and that the hope of doing still more by systematic scientific art is fully justified.

I might hereupon proceed to my project straightway. I perceive, however, that it may be urged, that as mere civilising influences can of themselves effect so much, they might safely be left to themselves to complete, through the necessity of their demands, the whole sanitary code. If this were so, a formula for a city of health were practically useless. The city would come without the special call for it.

I think it probable the city would come in the manner described, but how long it would be coming is hard to say, for whatever great results have followed civilisation, the most that has occurred has been an unexpected, unexplained, and therefore uncertain arrest of the spread of the grand physical scourges of mankind. The phenomena have been suppressed, but the root of not one of them has been touched. Still in our midst are thousands of enfeebled human organisms which only are comparable with the savage. Still are left amongst us the bases of every disease that, up to the present hour, has afflicted humanity.

The existing calendar of diseases, studied in connection with the classical history of them, written for us by the longest unbroken line of authorities in the world of letters, shows, in unmistakable language, that the imposition of every known malady of man is coeval with every phase of his recorded life on the planet. No malady, once originated, has ever actually died out; many remain as potent as ever. That wasting fatal scourge, pulmonary consumption, is the same in character as when Cœlius Aurelianus gave it description; the cancer of to-day is the cancer known to Paulus Eginæta; the Black Death, though its name is gone, lingers in malignant typhus; the great plague of Athens is the modern great plague of England, scarlet fever; the dancing mania of the Middle Ages and convulsionary epidemic of Montmartre, subdued in its violence, is still to be seen in some American communities, and even at this hour in the New Forest of England; smallpox, when the blessed protection of vaccination is withdrawn, is the same virulent destroyer as it was when the Arabian Rhazes defined it; ague lurks yet in our own island, and, albeit the physician is not enriched by it, is in no symptom changed from the ague that Celsus knew so well; cholera, in its modern representation, is a more terrible malady than its ancient type, in so far as we have knowledge of it from ancient learning; and even that fearful scourge the great plague of Constantinople, the plague of hallucination and convulsion which raged in the fifth century of our era, has, in our time, under the new names of tetanoid fever and cerebro-spinal meningitis, been met with here and in France, and in Massachusetts has, in the year 1873, laid 747 victims in the dust.

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* An Address by Dr. B. W. Richardson, F.R.S., at the Brighton meeting of the Social Science Association. Revised by the author.

I must cease these illustrations, though I could extend them fairly over the whole chapter of disease, past and present. Suffice it if I have proved the general proposition, that disease is now as it was in the beginning, except that in some examples of it it is less virulent; that the science for extinguishing any one disease has yet to be learned; and that, as the bases of disease exist, untouched by civilisation, so the danger is ever imminent, unless we specially provide against it; that the development of disease may occur with original virulence and fatality, and may at any moment be made active by accidental or systematic ignorance.

I now come to the design I have in hand. Mr. Chadwick has many times told us that he could build a city that would give any stated mortality, from fifty, or any number more, to five, or perhaps some number less, in the thousand annually. I believe Mr. Chadwick to be correct to the letter in this statement, and for that reason I have projected a city that shall show the lowest mortality.

I need not say no such city exists, and you must pardon me for drawing upon your imaginations as I describe it. Depicting nothing whatever but what is at this present moment easily possible, I shall strive to bring into ready and agreeable view a community not abundantly favoured by natural resources, which, under the direction of the scientific knowledge acquired in the past two generations, has attained a vitality not perfectly natural, but approaching to that standard. In an artistic sense it would have been better to have chosen a small town or large village than a city for my description; but as the great mortality of states is resident in cities, it is practically better to take the larger and less favoured community. If cities could be transformed, the rest would follow.

Our city, which may be named *Hygeia*, has the advantage of being a new foundation, but it is so built that existing cities might be largely modelled upon it.

The population of the city may be placed at 100,000, living in 20,000 houses, built on 4,000 acres of land—an average of twenty-five persons to an acre. This may be considered a large population for the space occupied, but, since the effect of density on vitality tells only determinately when it reaches a certain extreme degree, as in Liverpool and Glasgow, the estimate may be ventured.

The safety of the population of the city is provided for against density by the character of the houses, which ensure an equal distribution of the population. Tall houses overshadowing the streets, and creating necessity for one entrance to several tenements, are nowhere permitted. In streets devoted to business, where the tradespeople require a place of mart or shop, the houses are four stories high, and in some of the western streets where the houses are separate, three and four storied buildings are erected; but on the whole it is found bad to exceed this range, and as each story is limited to 15 feet, no house is higher than 60 feet.

The substratum of the city is of two kinds. At its northern and highest part there is clay; at its southern and south eastern gravel. Whatever disadvantages might spring in other places from a retention of water on a clay soil, is here met by the plan that is universally followed, of building every house on arches of solid brickwork. So, where in other towns there are areas, and kitchens, and servants' offices, there are here subways through which the air flows freely, and down the inclines of which all currents of water are carried away.

The acreage of our model city allows room for three wide main streets or boulevards, which run from east to west, and which are the main thoroughfares. Beneath each of these is a subway, a railway along which the heavy traffic of the city is carried on. The streets from north to south which cross the main thoroughfares at right angles, and the minor streets which run parallel, are all wide, and, owing to the lowness of the houses, are thoroughly ventilated, and in the day are filled with sunlight. They are planted on each side of the pathways with trees, and in many places with shrubs and evergreens. All the interspaces between the backs of houses are gardens. The churches, hospitals, theatres, banks, lecture-rooms, and other public buildings, as well as some private buildings such as warehouses and stables, stand alone, forming parts of streets, and occupying the position of several houses. They are surrounded with garden space, and add not only to the beauty but to the healthiness of the city. The large houses of the wealthy are situated in a similar manner.

The streets of the city are paved throughout in the same material. As yet wood pavement set in asphalte has been found the best. It is noiseless, cleanly, and durable. Tramways are nowhere permitted, the system of underground railways being found amply sufficient for all purposes. The side pavements, which are everywhere ten feet wide, are of white or light grey stone. They have a slight incline towards the streets, and the streets have an incline from their centres towards the margins of the pavements.

From the circumstance that the houses of our model city are based on subways, there is no difficulty whatever in cleansing the streets, no more difficulty than is experienced in Paris. That disgrace to our modern civilisation, the mud-cart, is not known, and even the necessity for Mr. E. H. Bayley's roadway movable tanks for mud sweepings (so much wanted in London and other towns similarly built) does not exist. The accumulation of mud and dirt in the streets is washed away every day through side openings into the subways, and is conveyed, with the sewage, to a destination apart from the city. Thus the streets everywhere are dry and clean, free alike of holes and open drains. Gutter children are an impossibility in a place where there are no gutters for their innocent delectation. Instead of the gutter, the poorest child has the garden; for the foul sight and smell of unwholesome garbage, he has flowers and green sward.

It will be seen, from what has been already told, that in this our model city there are no underground cellars, kitchens, or other caves, which, worse than those ancient British caves that Nottingham still can show the antiquarian as the once fastnesses of her savage children, are even now the loathsome residences of many millions of our domestic and industrial classes. There is not permitted to be one room underground. The living part of every house begins on the level of the street. The houses are built of a brick which has the following sanitary advantages:—It is glazed, and quite impermeable to water, so that during wet seasons the walls of the houses are not saturated with tons of water, as is the case with so many of our present residences. The bricks are perforated transversely, and at the end of each there is a wedge opening, into which no mortar is inserted, and by which all the openings are allowed to communicate with each other. The walls are in this manner honeycombed, so that there is in them a constant body of common air let in by side openings in the outer wall, which air can be changed at pleasure, and, if required, can be heated from the firegrates of the house. The bricks intended for the inside wall of the house, those which form the walls of the rooms, are glazed in different colours, according to the taste of the owner, and are laid so neatly that the after adornment of the walls is considered unnecessary, and, indeed, objectionable. By this means those most unhealthy parts of household accommodation, layers of mouldy paste and size, layers of poisonous paper, or layers of absorbing colour stuff or distemper, are entirely done away with. The walls of the rooms can be made clean at any time by the simple use of water, and the ceilings, which are turned in light arches of thinner brick, or tile, coloured to match the wall, are open to the same cleansing process. The colour selected for the inner brickwork is grey, as a rule, that being most agreeable to the sense of sight; but various tastes prevail, and art so soon ministers to taste, that, in the houses of the wealthy, delightful patterns of work of Pompeian elegance are soon introduced.

As with the bricks, so with the mortar and the wood employed in building; they are rendered, as far as possible, free of moisture. Sea-sand containing salt, and wood that has been saturated with sea-water, two common commodities in badly-built houses, find no place in our modern city.

The most radical changes in the houses of our city are in the chimneys, the roofs, the kitchens, and their adjoining offices. The chimneys, arranged after the manner proposed by Mr. Spencer Wells, are all connected with central shafts, into which the smoke is drawn, and, after being passed through a gas furnace to destroy the free carbon, is discharged colourless into the open air. The city, therefore, at the expense of a small smoke rate, is free of raised chimneys and of the intolerable nuisance of smoke. The roofs of the houses are but slightly arched, and are indeed all but flat. They are covered either with asphalte, which experience, out of our supposed city, has proved to last long and to be easily repaired, or with flat tile. The roofs, barricaded round with iron palisade, tastefully painted, make excellent outdoor grounds for every house. In some instances flowers are cultivated on them.

The housewife must not be shocked when she hears that the kitchens of our model city, and all the kitchen offices, are immediately beneath these garden roofs; are, in fact, in the upper floor of the house instead of the lower. In every point of view, sanitary and economical, this arrangement succeeds admirably. The kitchen is lighted to perfection, so that all uncleanliness is at once detected. The smell which arises from cooking is never disseminated through the rooms of the house. In conveying the cooked food from the kitchen, in houses where there is no lift, the heavy-weighted dishes have to be conveyed down, the emptied and lighter dishes upstairs. The hot water from the kitchen boiler is distributed easily by conducting pipes into the lower rooms, so that in every room and bedroom hot and cold water can at all times be obtained for washing or cleaning purposes; and as on every floor there is a sink for receiving waste water, the carrying of heavy pails from floor to floor is not required. The scullery, which is by the side of the kitchen, is provided with a copper and all the appliances for laundry work; and when that is done at home, the open places on the roof above make an excellent drying ground.

In the wall of the scullery is the upper opening to the shaft of the dust-bin. This shaft, open to the air from the roof, extends to the bin under the basement of the house. A sliding door in the wall opens into the shaft to receive the dust, and this plan is carried out on every floor. The coal-bin is off the scullery, and is ventilated into the air through a shaft, also passing through the roof.

On the landing in the second or middle stories of the three-storied houses there is a bath-room, supplied with hot and cold water from the kitchen above. The floor of the kitchen and of all the upper stories is slightly raised in the centre, and is of smooth grey tile; the floor of the bath-room is the same. In the living-rooms, where the floors are of wood, a true oak margin of floor extends two feet around each room. Over this no carpet is ever laid. It is kept bright and clean by the old-fashioned bees'-wax and turpentine, and the air is made fresh and ozonic by the process.

Considering that a third part of the life of man is, or should be, spent in sleep, great care is taken with the bedrooms, so that they shall be thoroughly lighted, roomy, and ventilated. Twelve hundred cubic feet of space is allowed for each sleeper, and from the sleeping apartments all unnecessary articles of furniture and of dress are rigorously excluded. Old clothes, old shoes, and other offensive articles of the same order are never permitted to have residence there. In most instances the rooms on the first floor are made the bedrooms, and the lower the living-rooms. In the larger houses bedrooms are carried out in the upper floor for the use of the domestics.

To facilitate communication between the kitchen and the entrance-hall, so that articles of food, fuel, and the like may be carried up, a shaft runs in the partition between two houses, and carries a basket lift in all houses that are above two stories high. Every heavy thing to and from the kitchen is thus carried up and down from floor to floor and from the top to the basement, and much unnecssary labour is thereby saved. In the two-storied houses the lift is unnecessary. A flight of outer steps leads to the upper or kitchen floor.

(*To be continued.*)

NOTES

THE reorganisation of the German Seewarte at Hamburg makes very satisfactory progress. To the Third Section is assigned the duty of issuing storm-warnings for the German coasts, and the investigation of the meteorological conditions on which the warnings depend. Hitherto meteorology has been prosecuted in Germany exclusively in its climatic aspects. It is now intended, whilst keeping in view what is required for climatic researches, to give more special attention to the investigation of weather-conditions, simultaneously observed over a wide area, and to the movements and changes taking place in the great currents of the atmosphere. In carrying out these objects, stations of the first order are established at Hamburg, Memel, Neufahrwasser, near Danzig, Swinemünde, Warnemünde, Keitum in Sylt, Borkum, Wilhelmshafen, and Kiel, at which, in addition to the ordinary instruments of observation, self-registering barometers and anemometers are erected. At these places observations are made at 8 A.M., noon, and 4 and 8 P.M., of which the observations at 8 A.M. and 4 P.M. are sent by telegraph to Hamburg. To these nine stations and some others on the German coasts at which wind and weather only are noted, the Seewarte intends to add sixteen others, situated inland in different parts of Germany, in selecting which particular attention is to be given to the position of the station and the instruments, so that really good observations of wind and temperature will in each case be furnished. The action taken by the German Seewarte to secure that the observations of temperature and wind will be of such a quality that they can be used in scientific investigations of weather changes, is deserving of all praise, the more so since these observations as at present made are often of very doubtful quality and in many cases worse than useless, considered as data for weather-inquiries.

ON the occasion of the centenary of the Genevan Society of Arts, founded in 1776, that body proposes to offer a number of prizes in its various departments. A most important service which the Academy will render to horology will be the International Competition in the Regulation of Pocket Chronometers. The trials of these chronometers will take place at the Geneva Observatory, under the superintendence of M. Plantamour, the director. All chronometers intended for the competition must be forwarded to him before mid-day of February 14, 1876. All competitors not resident in Geneva should correspond with the Observatory through a resident agent, who will manage all the details. M. J. B. Grandjean, president of the Section of Horology of the class, offers his services gratuitously to makers who have no agent in Geneva. Each chronometer should be accompanied by a paper containing data to identify the chronometer, details of its construction, &c. The trial will last fifty-two days from February 15, 1876, divided into nine periods. In a hot chamber and in an ice-house (*glacière*) the chronometers will be tested by being placed in all possible positions. All chronometers not complying with the following conditions will be excluded from competition:—1. The mean variation from day to day ought not to exceed six-tenths of a second so long as the chronometer preserves the same position in the Hall of the Observatory. 2. The values which express the mean rates during each of the periods except that of the hot chamber and the ice-house, ought to agree with their mean in the limits of two seconds more or less. 3. The error of compensation determined by the comparison of the rates in the hot chamber and in the ice-house ought not to exceed two-tenths of a second of degree centigrade. 4. The difference of rates between periods six and nine (both in the Observatory Hall, horizontal position, dial above), *i.e.* before and after the proofs relative to temperature, ought not to be above one second in twenty-four hours. The value of the results obtained in the trials which concern the two former conditions will have an importance double that which will be given to the two latter. No competitor can receive two prizes. A sum of 3,000 francs at least will be devoted for the purpose of awarding gold medals, or an equivalent value, to competitors who will have been judged worthy. A number of medals in silver and bronze will also be awarded. Those who wish for further details concerning this and other competitions, should apply to the Secretary of the Academy.

OUR readers will hear with regret that the well-known observatory at Twickenham belonging to Mr. Bishop, and presided over by Mr. Hind, is shortly to be dismantled and the instruments presented to the Royal Observatory at Naples. This, however, will probably not take place till the latter part of next year. Mr. Bishop has, we believe, been induced to part with his Twickenham property mainly on account of the benefit he found from residence in a southern climate. Not wishing to sell his scientific apparatus, he offered it by letter through Prof. de Gasparis to the Italian Government for the use of the Royal Observatory of Naples, where we believe an equatorial instrument of about the dimensions of the one at Twickenham was much desired. The offer was accepted in the first instance by telegram, and Mr. Bishop has this week received the formal authorisation of the Italian Minister of Public Instruction permitting the gift for the use of the Observatory at Naples. The most useful portion of the valuable library collected by Mr. Bishop's father (so long treasurer of the Royal Astronomical Society) may probably accompany the instruments.

IN 1859 Napoleon III. published a decree ordering that a prize of 20,000 francs should be presented every two years by the French Institute, each of the five academies being in turn authorised to nominate the candidate, and the choice to be ratified by the whole body of the Institute. The first laureate was M. Thiers, proposed by the Académie Francaise for 1861, on the ground of the excellency of his historical works. In 1863 the prize was proposed by the Academy of Inscriptions, and given to M. Jules Oppert, for his Assyrian discoveries. In 1865 M. Wurtz was proposed by the Academy of Sciences, for his discoveries in chemistry. In 1867 M. Henri Martin was selected by the Academy of Moral Sciences, for his History of France. In 1869 M. Guizot was elected by the Académie Francaise, using its right for the second time. In 1873 the Academy of Inscriptions selected M. Mariette, for his Egyptian discoveries. The Academy of Sciences having to exert its prerogative this year, has, it is stated, selected M. Paul Bert. It appears that the ground of selection is his "discoveries on the effects of oxygen in the act of respiration." M. Claude Bernard declared that these discoveries are the most astounding which have been made since Priestley dicovered that gas. These conclusions will not be accepted without opposition, even in France, although the Academy is said to have ratified the award without any objection. The lamented *Zenith's* ascent was organised in order to test the accuracy of M. Bert's conclusions.

THE Natural Science Lectures at Cambridge during the Michaelmas term present several new features of interest. The list of lectures, practical courses, and classes is now, happily, so long that it is impossible for us to notice them in detail. Prof. Dewar will commence his career as a Cambridge Professor, and inaugurate a new departure in the history of the Jacksonian Chair, by lecturing on Dissociation and Thermal Chemistry. Prof. Liveing's laborious course of instruction in Spectroscopic Analysis, in which successive batches of students are taught at successive hours of the afternoon, will be resumed. Mr. Apjohn will lecture on Volumetric Analysis, at Caius Laboratory, and Dr. H. N. Martin on Physiological Chemistry at Christ's College. Prof. Liveing promises a course on the History of Chemistry in the ensuing May term. In addition to Mr. Bridge's ordinary course of practical work in Comparative Anatomy, a valuable series of lectures with practical instruction in Morphology will be given by Mr. F. Balfour, of Trinity, and Mr. A. M. Marshall, of St. John's. Dr. Michael Foster's usual course of Practical Physiology and Histology will this term meet in two sections, elementary and advanced. Prof. Hughes's courses are divided into three sets. On Tuesdays he will lecture on Physical Geography and Elementary Geology; Thursdays, on the period represented by the depositions between the Lower New Red (Permian) and the top of the chalk inclusive; Saturdays, on various unconnected vexed questions. Prof. Hughes may be expected to propound many novel views, which Prof. Hull called heresies at Bristol, as to the Permian, Rhætic, and Triassic beds.

PROF. STOKES lectures at Cambridge this term on Double Refraction and Polarisation, Prof. Challis on Practical Astronomy and Magnetism, and Prof. Cayley on a course of Pure Mathematics.

INTELLIGENCE has been received at Sydney that the expedition under the leadership of Mr. Macleay, which left Sydney in the *Chevert* about four months ago to explore New Guinea, has become disorganised, and is returning. At the same time a report has reached Sydney that a large navigable river has been discovered in New Guinea.

DURING the past week the Social Science Association has been holding its meetings at Brighton. In all the Sections much business was done in the way of reading papers and subsequent discussion, though we regret to see that the attendance, especially of townspeople, was considerably below previous years. Few of the papers call for notice by us. The most striking, if not indeed the most valuable paper read, was that of Dr. B. W. Richardson, which we print elsewhere. The inaugural address, by Lord Aberdare, dealt with the subject of "Crime." Of other papers read we may note that of Sir Charles Reed, president of the Education Section, on the subject of "Education," principally dealing with its elementary aspect. A paper was read by the Hon. G. C. Brodrick on the question, "How can the influence of the Universities be most effectively exerted in the general education of the country?" Among other methods of reform he advocated the encouragement of literary and scientific research by University grants. Mr. Brodrick evidently is of opinion that our two great Universities are still far behind the age, and this was the tone of the discussion which followed. Miss Sherriff's paper on the question, "Is a fair proportion of the endowments of the country made applicable to female education?" is worthy of attention. In the course of the paper she gave an account of the progress of the Girls' Public Day School Company.

THE Sea-Lions, the expected arrival of which we mentioned last week, reached London on Tuesday, and were forwarded to Brighton yesterday.

DR. CARPENTER has declined to stand for the Lord Rectorship of Aberdeen University.

DR. W. J. RUSSELL has been appointed Examiner in Chemistry at the Royal College of Physicians, London.

THE open Scholarship at St. Bartholomew's Hospital, value 100*l*., has been awarded this year to Mr. C. Pardey Lukis.

WE have had forwarded to us two photographs of a mounted specimen of an almost complete Solitaire (*Pezophaps solitarius*), found, with a second, in the island of Rodriguez, in the June of this year, by Mr. J. Caldwell, the Assistant Colonial Secretary of Mauritius, and Sergeant Morris. These specimens, together with that procured by Mr. Slater, one of the naturalists to the Venus Transit Expedition, will settle some points in the osteology of the peculiar extinct Columbine birds, of which so many separate bones have been obtained.

SOME interesting results were given by Mr. H. M. Taylor, Fellow and Tutor of Trinity College, Cambridge, in a paper "On the Relative Values of the Pieces at Chess," read before the British Association at Bristol. He found by a mathematical process that if a knight and king of different colours were placed on a chessboard at random, the odds against the king being in check were 11 to 1; if a bishop and a king, 31 to 5; if a rook and a king, 7 to 2; and if a queen and a king, 23 to 13. If, however, we consider only safe check (*i.e.* check in which the king is unable to take the piece), the odds are respectively 11 to 1, 131 to 13, 5 to 1, 107 to 37. From these numbers we can obtain a fair theoretical measure of the relative values of the pieces. Thus, if we take as our measure the chance of safe check, the values of the knight, bishop, rook, and queen are in the ratio 12, 13, 24, 37, while the values of these pieces in the same order as given by Staunton are 3·05, 3·50, 5·48, and 9·94, the value of the pawn being taken as unity. Mr. Taylor remarks that the value of a pawn depends so much on the fact that it is possible to convert it into a queen, that the method does not appear applicable to it.

MESSRS. H. S. KING and Co. will publish, during the forthcoming season, the following new volumes of their International Scientific Series:—"Animal Parasites and Messmates," by M. Van Beneden, Professor of the University of Louvain, and Correspondent of the Institute of France. It will contain eighty-three illustrations.—"The Nature of Light," with a general account of physical optics, by Dr. Eugene Lommel, Professor of Physics in the University of Erlangen. This work will contain a table of spectra in chromolithography and a large number of other illustrations.—"The Five Senses of Man," by Professor Bernstein, of the University of Halle.—"Fermentations," by Professor Schutzenberger, Director of the Chemical Laboratory at the Sorbonne; and a new edition of Dr. Hermann Vogel's "Chemical Effects of Light and Photography."

TWO nests of English Humble-bees were last week sent to New Zealand by Mr. Frank Buckland, for the Canterbury Acclimatisation Society. These insects are specially desired in New Zealand for the purpose of fertilising the common clover; the proboscis of the common bee is not sufficiently long to reach down to the pollen of the clover flower, while the humble-bee is enabled to do so. In this way the insect is expected to do great service to the agriculturist by largely extending the growth of the clover. The bees were packed in their own nests in two boxes, and will be under the charge of a member of the New Zealand Council, who is provided with every necessary for their welfare during the voyage. They are expected to arrive about the middle of January—midsummer at the antipodes.

THE production of silk in South America is rapidly increasing both in quantity and quality. At a local exhibition recently held at Buenos Ayres, some samples, both raw and manufactured, were shown, which compared favourably with the best silks of Asia. The climate of Brazil seems to be especially well suited for the cultivation of the silkworm, which feeds on the leaves of the *Palma christi*, a plant which grows in abundance in the country. The Government of Brazil is said to be contemplating offering subsidies for the cultivation of silkworms in the country.

ALMOST every day the French *Journal Officiel* publishes a list of professorships created by the Government in the several academies, principally in the provinces, in order to enable them to sustain any competition which may be eventually offered by the free academies. The law of the liberty of instruction will benefit unquestionably not only the public at large, but also the official universities, in raising a spirit of emulation.

A PROFESSOR of the Academy of Grenoble, M. Violle, made several balloon ascents in the Alps last summer in order to measure the degree of heat generated by the sun, and consequently the temperature emanating from that body. It is said by the *Liberté* that M. Violle is quite opposed to the idea that the degree of temperature is immense; he says that it is not much hotter than temperatures produced in the laboratories. Details will shortly be published in the *Comptes Rendus*.

THE *Geographical Magazine* for October contains a detailed account of the voyage of the Arctic Expedition from Portsmouth to Waigat, and of the work of the *Valorous*. A map of part of the North Atlantic showing the tracks of the three ships accompanies the paper, the sea being tinted according to depth. There is also a section of the Atlantic showing the soundings of the *Valorous*, and a plan of the harbour of Holsteinberg, off which the ship grounded.

THE *Times* and other London papers of Tuesday contain letters from members of the *Pandora* Arctic Expedition, under Capt. Young. The expedition reached Disco on August 7, and all was going well, though on the way out squalls and contrary winds had been met with. Capt. Young was to leave Disco on the 10th.

PROF. ED. MORREN has published a small biography of Charles de l'Escluse, commonly known as Clusius, after whom a small order of plants was named by Lindley. Born in 1526 and dying in 1609, he was for sixteen years Professor of Botany at the University of Liège. His works are comprised in two folio volumes—"Rariorum Plantarum Historia," and "Exoticorum Libri Decem," and he was one of the pre-Linnean naturalists who attempted a classification of plants founded on artificial characters.

THE first part has just been published of the long-announced "Medicinal Plants," by Messrs. Bentley and Trimen. Each part is to contain eight coloured plates of plants included in the Pharmacopœia of Britain, India, or the United States, together with letterpress comprising a full description of the plant, its nomenclature, geographical distribution, &c., and an account of its properties and uses.

IN a recent number of the *Transactions of the Academy of Science of St. Louis*, Mr. Charles Riley describes the curious habits of two insects which occur alive in the pitchers of *Sarracenia variolaris*. The first is a small moth (*Xanthoptera semicrocea*), which lays its eggs within the pitcher. The young caterpillars there weave a gossamer-like web and feed on the cellular tissue of the leaf. The putrid remains of insects previously captured, which have perished, are covered over by the excrements of these caterpillars. The second is a dipterous insect (*Sarcophaga sarraceniæ*). The mature fly is stated to drop a number of the larvæ into the pitcher, where they feed on the decaying remains of other insects, and finally burrow through the bottom of the pitcher into the ground, where they undergo their transformations.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*) from W. Africa, presented by Miss A. J. Brown; a Brown Bear (*Ursus arctos*) from Russia, presented by Mr. A. Vale; two Vervet Monkeys (*Cercopithecus lalandii*) from S. Africa, presented by Mr. Abbett; two Grey-breasted Parrakeets (*Bolborhynchus monachus*) from Monte Video, presented by Miss Maiden; a Peewit (*Vanellus cristatus*), European, presented by Dr. William Brewer; a Brown Bear (*Ursus arctos*) from Russia, two Argus Pheasants (*Argus giganteus*) from Malacca, an Alligator (*Alligator mississippiensis*) from the Mississippi, a Common Snake (*Tropidonotus natrix*) from South Tyrol, deposited; two Graceful Ground Doves (*Geopelia cuneata*) from Australia, received in exchange; a Scolopaceous Rail (*Aramus scolopaceus*) from S. America, purchased.

SCIENTIFIC SERIALS

THE *Journal of the Chemical Society*, July and August, 1875.—These numbers contain the following papers, besides the usual number of abstracts from other serials:—On Narcotine, Cotarnine, and Hydrocotarnine (Part I.), by G. H. Beckett and Dr. C. R. A. Wright. The authors first treat of the preparation of cotarnine, then of its conversion into hydrocotarnine, and the action of oxidising agents upon the latter. Finally, there are accounts of the action of nascent hydrogen, of boiling baryta water, and of ordinary water on narcotine. As an appendix to this interesting paper we have a treatise by Dr. F. Pierce, on the Physiological Action of Cotarnine and Hydrocotarnine. It appears from this that the addition of hydrogen to cotarnine converts a base which is apparently inert into a very active substance, the change in physiological action being far more striking even than the alteration brought about in the physical and chemical properties.—On Andrewsite and Chalkosiderite, by Prof. Story Maskelyne.—An Examination of Methods for effecting the quantitative separation of Iron Sesquioxide, Alumina, and Phosphoric Acid, by Dr. Walter Flight; this paper is very elaborate and interesting.—On a New Method of Supporting Crucibles in Gas Furnaces, by C. Griffin.—On some points in Examination of Waters by the Ammonia method, by W. H. Deering.—On the Structure and Composition of certain Pseudomorphic Crystals, having the form of Orthoclase, by J. Arthur Phillips.—On Sodium Ethylthiosulphate, by Wm. Ramsay.—On the Action of Organic Acids and their Anhydrides on the Natural Alkaloids (Part IV.) by G. H. Beckett and Dr. C. R. A. Wright. The authors treat of the action of polybasic acids on morphine and codeine, of succinic acid on morphine, of camphoric acid on codeine and morphine, of tartaric and oxalic acids on codeine, and of oxalic acid on morphine.—A note, by the same authors, on the Sulphates of Narceine and other Narceine derivatives; giving an account of the action of nascent hydrogen, of acetic anhydride, and of ethyliodide upon narceine.—On the Action of Chlorine on Pyrogallol, by John Stenhouse and Ch. E. Groves; the authors speak of two substances not described before, with such minuteness, and call them Mairogallol and Leucogallol.—In an appendix Mr. W. J. Lewis gives an account of the crystallographic characters of Mairogallol.—On the Action of Dilute Mineral Acids on Bleaching Powder, by Ferdinand Kopfer; a very elaborate treatise with numerous tables and results of analysis, going far to elucidate the still somewhat doubtful chemical composition of the substance commonly known as "chloride of lime."

THE most important article in the *Journal of Botany* for September is by Mr. J. W. Clark, "On the absorption of nutritive material by the leaves of some insectivorous plants." In a very carefully conducted series of experiments, a number of flies were supplied to the bases of *Drosera rotundifolia* and *intermedia*, whose bodies had previously been soaked in lithium citrate; care was taken that the salt did not reach any other part of the plant externally; and after a period of about forty-eight hours the leaf-stalks were incinerated and tested by the spectroscope for lithium, a perceptible quantity of which was found; thus appearing to prove, in opposition to Prof. Morren's view, that the leaf does actually absorb and digest. A few experiments were tried on *Pinguicula lusitanica* with the same result. The plate in this number represents an interesting new lichen, *Stigmatidium dendriticum*; and in that for October the mode of germination of *Chara*, to illustrate a translation of De Bary's important paper on this subject. It also contains a description of a collection of Chinese ferns gathered by Mr. J. F. Quekett, and other shorter papers.

SOCIETIES AND ACADEMIES

LONDON

Royal Microscopical Society, Oct. 6.—Mr. H. C. Sorby, F.R.S., president, in the chair.—A large number of presents to the Society were announced, and special attention was directed by the Secretary to a turn-table by Mr. Cox, of the U.S. America.—A new microscope was exhibited by Messrs. Beck and Beck, and a new form of hand magnifier by Mr. Browning.—Mr. Slack made some observations upon certain Lepidoptera armed with boring probosces, by which they were said to pierce oranges and other fruit. A comparison between drawings of an Australian species appeared to show that it was identical with one originally described by Mr. M'Intire at the meeting in April 1874.—Mr. Beck exhibited a specimen of blood discs of the *Amphiuma means*, which are supposed to be the largest in existence.—A paper by Dr. R. Piggott, on the identical characters of spherical and chromatic aberration, was read by the Secretary.—Dr. C. T. Hudson gave a highly interesting description of a new Melicertian, for which he proposed the name of *M. tyro*.

PARIS

Academy of Sciences, September 27.—M. Frémy in the chair.—The following papers were read:—Meridional observations of the minor planets made at the Paris Observatory during the first half of the year 1874, by M. Leverrier.—On the formation of hail; reply to a note by M. Renou, by M. Faye.—Twelfth note on the electric conductivity of bodies which are imperfect conductors, by M. Th. du Moncel.—Irregular variation of hybrid plants and deductions which can be made therefrom, by M. Ch. Naudin.—On the development of the pulmonary gasteropoda, by M. H. Fol.—Transformation of blood into a soluble powder; chemical, physical, and alimentary properties of this powder, by M. G. Le Bon.—Notes towards the history of the genus Phylloxera, by M. Lichtenstein.—On the particularities presented by the phenomenon of the contacts during the observation of the transit of Venus at Pekin; note by M. Fleuriais.—On the putrefaction produced by bacteria in the presence of alkaline nitrates, by M. Mensel.—Remarks concerning a note by M. F. Glénard on the spontaneous coagulation of blood removed from the organism, by MM. E. Mathieu and V. Urbain.—Quantities of nitrogen and of ammonia contained in beet-roots, by MM. Champion and H. Pellet.—On the internal structure of the hailstone and its probable mode of formation, by M. A. Rosenstiehl.—Extract from a letter from Colonel Buchwalder on hailstorms, presented by M. Faye.—Letter from M. E. Solvay to M. E. Becquerel on the formation of hail, presented by M. Faye.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Journal of the Iron and Steel Institute (Spon).—Thermo-Dynamical Phenomena; or, the Origin and Physical Doctrine of Life: H. A. Hartley, of Madras (Longmans).—Animal Physiology: E. Tully Newton (Murby).—Figures of Characteristic British Fossils: W. H. Baily, F.L.S., F.G S. (Van Voorst).—Proceedings of the Natural History Society of Glasgow.—On Improved Dwellings: Charles Gatliffe, F.S.S. (Stanford).—Materialism: J. M. Winn, M.D., M.R.C.P. (Hardwicke).

AMERICAN.—The Recent Origin of Man: J. C. Southall (Philadelphia, Lippincott and Co.)—Preliminary Report upon a Reconnaissance through Southern and South-Eastern Nevada, made in 1869, by Lieutenants Wheeler and Lockwood.—The ,Origin of the Sun's Heat (Troy, U.S., Scribner).—Daily Weather Reports, December 1872 and December 1873 (Signal Service U.S. Army, Washington).

FOREIGN.—Résumé de quelques Observations astronomiques et meteorologiques: J. C. Houzeau (Brussels, F. Hayez).—Matériaux pour servir à l'etudie de la Faune profonde du la Léman: Dr. F. A. Forel (Lausanne, Rouge et Dubois).—Die Fortschritte des Darwinismus: T. W. Spengel (Leipzig, E. H. Mayer).—Culturgeschichte in ihrer Natürlichen Entwicklung bis zur Gegenwart: von F. von Hellwald (Augsburg, Lampart et Cie.)—Charles de l'Escluse, sa Vie et ses Œuvres: E. Morren (Liege).—Annaes do Observatorio do Infante D. Luiz Magnetismo Terrestre, 1870 and 1874 (Lisboa).

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THURSDAY, OCTOBER 21, 1875

BANCROFT'S "RACES OF THE PACIFIC STATES"

The Native Races of the Pacific States of North America. By Hubert Howe Bancroft. Vol. ii. Civilised Nations. Vol. iii. Myths and Languages. (London: Longmans and Co., 1875.)

THE publication of this great anthropological work goes on rapidly, and no doubt the two remaining volumes will be out in a few months. Every reader must be glad that the author departs more and more from his original plan of making his book a mere museum of compiled information, and now makes some attempt towards interpreting the mythical and religious puzzles of Mexico and Central America. The introductory essays on the philosophy of civilisation and religion may not be of startling originality, but at any rate they are the deliberately adopted conclusions of a writer with an unusually large knowledge of the facts. Mr. Bancroft has evidently come, like so many thinkers of this generation, under the genial influence of Emerson. To his mind, the world seems animated by a "Soul of Progress," individual men working on unknowingly, and often against their will, towards a mysterious end which is the goal of civilisation. The two apparently oppugnant agencies of good and evil tend together toward one end; "Night or day, love or crime, leads all souls to the good." At one stage of civilisation blind faith is essential to give strength to man's belief, till at another stage scepticism has to come in and destroy the scaffolding of superstition, leaving the mental fabric which has been reared by its means. War and tyranny do the work of consolidating nations and founding political institutions, till the time comes when, having done their work in promoting good, they may themselves be cast out for being evil. Institutions which were at first the essentials of civilisation become, as man advances, a drag on his progress, and have to be abolished. The union of Church and State, of superstition and despotism, a union still necessarily kept up in some of the more backward civilisations, was in barbarous ages a real means of moral and intellectual advance from a wilder and lower state. Thus we see in every phase of development the result of a social evolution, but where it is to end, whither it is tending, we cannot tell as yet, nor can we yet fully understand its guiding laws, for "like all other progressional phenomena, they wait not upon man; they are self-creative, and force themselves upon the mind age after age, slowly but surely, as the intellect is able to receive them."

One really stands in need of some such hopeful theory of social evolution, in reading the details of Mexican religion. The chapter on Public Festivals is a sickening catalogue of horrors. It begins mildly with the priests scarifying and mutilating themselves, especially by boring holes in their tongues to pass sticks through. Then comes the sacrifice of a number of sucking infants, who were carried in procession on gorgeous litters to be slain on the mountains and in the lake, some of the bodies being brought back as a delicacy for the priests and nobles. Then an account of a festival, where the human victims, having had their hearts cut out in the usual way on the sacrificial stone, were then flayed; their flesh was eaten at a banquet, and the lads of the colleges dressed up in their skins and went about singing, dancing, and asking for contributions: "those who refused to give anything received a stroke in the face from the dangling arm." A little later comes the feast of the Fire-god, where the priests carried captives naked and bound, on their shoulders up to the top of the temple, and pitched them into a huge fire of glowing coals, where they watched them writhe and crackle till it was time to rake the almost dead bodies out and cut them open; the proceedings ended with a dance and climbing a maypole. Even at the harvest festival, an occasion of jollity, when everybody danced and feasted, these sanguinary religionists brought out a criminal, put him between two immense stones balanced opposite each other, and let them fall together so as to smash him.

It is not easy, in the present condition of Sociology, to account for this monstrous development of cruelty in the Mexican religion. The people seem not to have been either wicked or hard-hearted in their private life, but to have been the same mild and rather stolid people that their descendants still remain. The Aztec criminal code was indeed of the severest, and even Draco might have scrupled to have a man beaten to death with clubs for getting drunk, or to make stealing a tobacco-pouch a capital crime. But there is nothing extraordinary in a barbarous government trying to stamp out even small offences by ferocious punishments. That these lose much of their effect by the public mind becoming too habituated to them, is a discovery which comes at a higher stage of statecraft. The state of civil society in ancient Mexico was on the whole like that of many other half-civilised communities. It was their religion which was exceptional, in the enormous frequency of human sacrifice combined with cannibalism, it being the ordinary motive for war to obtain a supply of captives for victims. The nearest parallel is to be found in nations of West Africa, where human sacrifice and cannibalism form a great part of the religious observances. The Dahoman custom of dividing the human victim, the blood for the fetish, the head for the king, the body for the people, reminds us of similar arrangements described by Mr. Bancroft in Central America. On the other hand, the religion of Mexico, unlike those of West Africa, was one in which asceticism and self-torture prevailed both among priests and people. They fasted long and severely in their religious rites, and were everlastingly drawing blood from their bodies with aloe-thorns and obsidian knives, piercing their tongues as a penance for evil speaking, and other parts of their bodies for appropriate sins. This religious ordinance is almost peculiar to the group of connected nations of Mexico and Central America, and thus has a certain ethnological interest. The Mexican combination of religious austerity and cruelty may be instructively compared with that which developed itself in mediæval Europe.

Mr. Bancroft is inclined to think that the civilisation of Mexico and Central America had sunk somewhat from its highest point at the time of the Spanish discovery. He believes in the high culture of the famous traditional Toltecs, who were of the same stock with their successors the Aztecs, both belonging to the wide Mexican race to which modern writers apply the old designation of Nahua (Nahuatl). But his description of the Aztec civilisation at the time of the Spanish Conquest scarcely suggests a state of decay. The handicrafts of the stonecutter, the weaver, and the goldsmith, the elaborate organisation of the priesthood and the army, of the colleges for training boys and girls, and of the guilds of merchants, were found by the Europeans in full vigour. The Mexicans not only had a system of picture-writing and kept their chronicles in it, but King Nezahualcoyotl is said to have made a law prescribing the penalty of death on historians who should record fictitious events. This same king made severe forest-laws to prevent the supply of wood in the country being exhausted, so that the people did not dare even to pick up the fallen wood. Such a state of things may indicate a certain stiffness and artificiality of law and custom, but hardly a fall from an earlier higher state. In any new discussion of the problem of American civilisation, for which these volumes afford the first ample collection of materials, we should prefer reasoning on Aztec life as Cortes saw it, to speculating on the institutions of the half mythical Toltecs of tradition.

In looking through the present volumes two observations suggest themselves. Mr. Bancroft has drawn up descriptions of the languages of the Pacific district which are of some use in defining the general structure of each, and justifying the class-arrangement which he adopts. But he only gives a few specimen words of each language, such as pronouns, numerals, incomplete parts of a verb, and perhaps a Lord's Prayer. We wish, considering the space he has spared for native myths, that he had found room for a series of concise grammars. The existing grammars and dictionaries of many of these languages, even such as Aztec and Maya, which are the spoken languages of large populations, are so scarce and costly as to be out of the reach of ordinary philologists. For instance, it is difficult to get sufficient information as to one of the most curious languages of Mexico, the Otomi, described by several writers as a real monosyllabic language imbedded among languages like the Aztec, whose formation is polysyllabic-agglutinative in the extreme. This is a most interesting phenomenon in philology, and we looked to Mr. Bancroft at least to settle the disputed point whether the Otomi tongue is really monosyllabic. There are plenty of polysyllables in it, such as *tayo*, dog; *nxuyo*, bitch; *mahetsi*, heaven; *nuga*, I. But the question is whether the statement is fully borne out, that "in words compounded of more than one syllable, each syllable preserves its original meaning." In the first two instances this is evidently true, *ta-yo*, *nxu-yo* being decomposable as "male dog," "female dog." Whether the other two words can be analysed we do not know. So interesting is the Otomi tongue for its bearing on the theory of the monosyllabic origin of language, that it would be worth while to collect and reprint everything that is known about it. For one thing thanks are due to Mr. Bancroft, that he insists on the merely accidental character of such resemblances as exist between Otomi and Chinese. Naxera's baseless theory of a connection between these two languages had publicity given to it by Prescott, and is not yet forgotten.

The collection of cosmogonic traditions in the third volume is remarkable, and may lead us to expect valuable results to science when the creation-myths of all tribes and nations of the world shall be put together and carefully analysed. Many of them are of course mere products of childish fancy. In Central California the story is that in the beginning the world was dark, so that men and beasts and birds were always stumbling and dashing against one another. The Hawk happening to fly in the face of the Coyote (Prairie-wolf), they mutually apologised, and set to improve things. The Coyote made balls of reeds and gave them with some pieces of flint to the Hawk, who flew up into the sky with them and set them alight. The sun-ball still glows red and fierce, but the moon-ball was damp, and has always burnt in a feeble, uncertain way. The Southern Californians, on the other hand, believe that the sun and moon were the first man and woman; women, descendants of the moon, are fair but fickle, for as she changes so they all change, say these savage philosophers. Such mythical fancies, of which there are numbers in this one district, fall within the province of the pure mythologist. But it is an interesting question whether, among the legends of catastrophes which altered the face of the earth and destroyed its inhabitants, there may be any dim recollections of actual events, recognisable by the antiquary or the naturalist. To take another example from California, the natives about Lake Tahoe ascribe its origin to a great natural convulsion. Their story is that their ancestors were once numerous and rich, but a stronger people rose up who defeated and enslaved them. Then the Great Spirit sent an immense wave across the continent from the sea, which engulfed both oppressors and oppressed, all but a small remnant. Those who remained of the ruling caste made the people build a great temple for refuge in case of another flood, and on the top of this the masters worshipped a perpetual fire. Soon, however, the earth was troubled again, this time with strong convulsions and thunders. The masters took refuge in their great tower, shutting out the slaves, who fled to the Humboldt River, and paddled for their lives, for the land was tossing like a troubled sea, casting up fire, smoke, and ashes. The Sierra was mounded up from the bosom of the earth, while the place where the great fort stood sank, leaving only the dome at the top exposed above the waters of Lake Tahoe.

Such is the local story, remarkable for its good descriptions of an earthquake-wave, an eruption, and a volcanic upheaval and subsidence. Whether it is founded on some fragmentary reminiscences of a real local catastrophe is a question which we leave to be answered by some geologist who has examined the district.

HUXLEY AND MARTIN'S "ELEMENTARY BIOLOGY"

A Course of Practical Instruction in Elementary Biology. By T. H. Huxley, LL.D., Sec. R. S., assisted by H. N. Martin, B.A., D.Sc. (London: Macmillan and Co., 1875.)

IN the preface to this work, Prof. Huxley tells that the object of his book is to serve as a laboratory guide to those who are inclined to study the principles of Biology as a single science, and not as one divided, except for the sake of convenience, into the two "disciplines," Zoology and Botany. To accomplish this end a certain number of readily obtainable plants and animals have been selected for minute description, in which the most important types of vegetable and animal organisation are capable of being demonstrated. With reference to each species selected, an account of its anatomy is given, which is followed by laboratory instructions as to the manipulatory detail necessary for its complete verification. The types selected include Yeast, Protococcus, the Proteus Animalcule, Bacteria, Moulds, Stoneworts, the Bracken Fern, the Bean Plant, the Bell Animalcule, the freshwater Polype and Mussel, the Crayfish and Lobster, and the Frog. As an illustration of the form in which the laboratory directions are given, the following quotation from a portion of the dissection of the Frog will serve as a fair example :—

"DISSECTION OF THE VISCERA IN THE VENTRAL CAVITY.

"1. Lay a frog, which has been killed with chloroform, on its back, and pin it out on a layer of paraffin or beeswax, under water ; divide the skin along the abdominal median line from the pelvis to the front of the lower jaw ; next make a transverse incision at each end of the longitudinal one, and then throw outwards the two flaps of skin thus marked out. The following points may now be noted :—

- "*a.* A great vein (*musculo-cutaneous*) on the under surface of each flap of skin, about the level of the shoulder.
- "*b.* Some of the muscles of the abdominal wall, covered by a thin aponeurosis ; through this latter can be seen—
  - "*α.* The *rectus abdominis*, running from pelvis to sternum, close to the middle line, and divided into a number of bellies by transverse tendinous intersections.
  - "*β.* Other muscles outside the rectus on each side.
- "*c.* The *pectoral region* : part of its hard parts in the middle line, only covered by tendinous tissue ; external to this, muscles running towards the shoulder-joint.
- "*d.* The *muscles of the throat* : small and with a general direction from the lower jaw towards the sternum and shoulder-girdle.

"2. Raise the tissues of the body-wall with a pair of forceps, and carefully divide them, a little to the right of the median line," &c.

From what has been said above it is evident that there are two features in this volume of Prof. Huxley's which call for special notice on account of their novelty. The first of these is that Botany and Zoology are taught in combination, as parts of the science of living organisations—Biology. The second is that the subject is taught practically ; in other words, with full information on how to observe the features described.

Most amateur students of so-called science, or collectors, run in a single groove of thought. They learn to recognise specific differences in those groups of animals, fossils, or plants which they honour with their patronage ; they discover minute variations in individual specimens, and frequently attempt to load nomenclature with fresh names, which may or may not have to be swamped in the mass of synonyms—already but too large —according to their knowledge of the literature of the subject they affect. In the scale of scientific investigators these stand lowest. They do good ; their work is indispensable ; the mental effort required for its production is, however, small, and is generally associated with a want of power to grasp general principles which is frequently quite surprising. The opportunity of seeing, or, better still, possessing "type" specimens is their highest gratification ; and their opinion on any point involving more than generic differences is unreliable.

A second class of student advances further. Collection of familiar forms is not the object kept in view by them. They study the literature of their subject, having previously received a sound educational foundation. They do not make fresh and independent observations themselves, but delight in verifying those of others. New facts they absorb ; and by engrafting them upon their previous ideas, modify the latter—generally prematurely —in a direction which they prophesy to be the science of the future. They draw extreme deductions on insufficient evidence, and are apt to fall whilst attempting to substantiate them. These are not to be trusted in the definition of a sub-kingdom.

A third class investigate on their own account. They study the works of others ; and by thoroughly digesting the new and old facts at their disposal, are in a position to modify generally accepted views on important questions by the publication of arguments as cogent as they are reliable. These original investigators have their independent views on the most general principles.

Such being the case, we may employ the scale of biological relationships as a rough standard of the mental capacities of working students. It leads us to look upon everything which tends to inclusiveness as an advance in the right direction, and everything in the opposite direction as retrograde. All biologists must therefore thank Prof. Huxley for having introduced into the preliminary training of students of Natural History the conception of the complete unity of plant- and animal-life, and of the comparative insignificance of the gulf between the two.

Prof. Huxley teaches Biology *practically*. The pupil has to see with his own eyes all that he reads about ; and what is more, he has to find what he is to see. Practical education is a praiseworthy characteristic of the present age. Numbers of laboratories, in this country and on the Continent, have been recently established for the teaching of Physics, Physiology, and lastly Biology. That this practical phase must be generally adopted in scientific education becomes more certain as the scientific training itself becomes more and more a part of the preliminary education. The tendency in recent times to estimate classics at a lower value as a discipline than formerly, is one which necessitates the introduction of a substitute ; of a means by which a training in the method of work shall be the mental exercise, whilst mere facts shall not have the prominence generally given them in the scientific lecture-room. As a training, practical biology offers all the requirements, at the same time that it leaves those who have pursued it, after they have finished their education, in a position peculiarly favourable for the prosecution of original investigation on their own account. From this view of the subject we have also therefore to thank Prof. Huxley for having added Biology to the list of those sciences which are taught practically as well as theoretically.

It has also special advantages in this direction. No expensive outlay is necessary for the purchase of apparatus ; a well-lighted room, together with a microscope, scalpels, forceps, and scissors, being nearly all that is essential to a biological laboratory. These can be procured by anyone; and the student when thus equipped with Huxley and Martin's "Practical Biology" in his hands, need only look around for some of the most easily obtainable animals, upon getting which he can start work in good earnest.

In the descriptive portion of the work there is one point to which we cannot help referring, which is in connection with the circulation of the blood. It is an explanation, originally given by Brücke, we believe, of the manner in which the mixed arterial and venous blood in the single ventricle of the frog is distributed in such a manner that the venous blood mostly enters the lungs. "It fills (during the systole) the conus arteriosus, and, finding least resistance in the short and wide pulmonary vessels, passes along the left side of the median valve into them. But as they become distended *and less resistance is offered elsewhere*, the next portion passes on the right side of the longitudinal valve into the aortic arches." The words italicised by us are those which it is difficult to comprehend, for it is evident that if the pulmonary artery offers less resistance at the commencement of the systole, it will do so all through the revolution in proportion to the relative calibre of its capillaries and those of the system generally; and then there is no reason why the valve should flap back.

OUR BOOK SHELF

Rotomahana, and the Boiling Springs of New Zealand. A Photographic Series of Sixteen Views, by D. L. Mundy. With descriptive notes by Ferdinand von Hochstetter, Professor of the Polytechnic Institution of Vienna. (London: Sampson Low and Co., 1875.)

THE autotype illustrations which form the main feature of this handsome volume are triumphs of the photographic art, and reflect the highest credit upon their author, Mr. Mundy. The photographs are on a scale quite large enough to give one a satisfactory idea of the main features of the various scenes intended to be portrayed; and by the judicious introduction into most of the views of the human figure, a good idea of the scale of the photographs is at once afforded.

The remarkable region illustrated by Mr. Mundy's series of photographs lies just about the centre of the North Island of New Zealand, in the south of the province of Auckland. The culminating or rather originating point of the phenomena described, Prof. Hochstetter regards as the still active volcano Tongariro, in the north of the province of Wellington. From this volcano three lines of volcanic action are supposed to proceed in a north-easterly direction by Lake Taupo to Lakes Rotorua, Rotoiti, and Rotomahana respectively, the last-mentioned line proceeding inwards as far as the marine volcano Whakari, in the Bay of Plenty; this line also, near its source, includes the hot springs at the head of Lake Taupo, about forty miles to the north of Tongariro. Another line, which follows to some length the outflow of the river Waikato from Lake Taupo, is marked by the hot springs and steam jets of Otumaheke and Orakeikorako, on the river's banks, and those of the Pairoa mountain range. The third line of action forming eruptions of this kind is exhibited in the hot springs of Rotorua and the solfataras of Rotoiti, which terminate these specimens of volcanic action on land, being situated near the sea-coast. While all along these three lines evidences of volcanic action are visible in the shape of hot springs, solfataras, geysers, mud-lakes, &c., the chief interest centres in Rotomahana, where the most beautiful and marvellous effects of this action are displayed. Though on a much smaller scale, the phenomena greatly resemble those which are seen in such profusion in the Yellowstone region of North America.

Mr. Mundy devotes most of his photographic views to the illustration of the phenomena to be witnessed in and around Rotomahana. This is one of the smallest lakes in the region, being scarcely a mile in length and a quarter of a mile in breadth; it is 1,088 feet above the sea, and the temperature of the lake itself varies from 60° to 100° Fahr. On the margin of the lake are many boiling springs, and around it are a great variety of phenomena similar to those which are witnessed in Iceland and in North America. It is impossible in a few words to give any adequate idea of these phenomena, and we must therefore refer our readers to Mr. Mundy's beautiful illustrations, and Prof. Hochstetter's brief but clear descriptions. One of the photographs gives a fine view of Lake Rotorua, about twelve miles north of Rotomahana, and the last four are devoted to the illustration of Lake Taupo and the phenomena to be seen in its neighbourhood. Rotomahana, we may state, is about forty-five miles N.N.E. of Lake Taupo, and about double that distance from Mount Tongariro.

Lake Taupo lies at a height of 1,250 feet above the sea, and no bottom has been found at a depth of 200 fathoms. Prof. Hochstetter conjectures that its waters, which have only one visible outlet, the Waikato, but many tributary streams, has a subterranean outlet to the north. It is this, he believes, which gives rise to the curious phenomena which abound in the region to which Mr. Mundy's photographs refer; the water, after being heated by underground volcanic fires, generates high-pressure steam that forces its way to the surface, bearing the characteristics of the rocks with which it has come into contact: the New Zealand springs, we should say, are divided into two distinct classes, the one alkaline, and the other acid. Whatever may be the value of Prof. Hochstetter's explanation of the phenomena, there is no doubt about the value of Mr. Mundy's illustrations of a district which seems to be all that now remains of a once extensive active volcanic region. While as a collection of well-executed views of great interest the work deserves a wide circulation, to the student of geology it is of great value, as affording a far more satisfactory idea of an important feature of the physical geography of New Zealand than any mere description can convey.

Elementary Lessons in Botanical Geography. By J. G. Baker, F.L.S., Assistant Curator of the Herbarium at Kew. (London: L. Reeve and Co., 1875.)

A WANT has long been felt of a small text-book for the use of lecturers and students dealing with the distribution of plants on the face of the globe. A work of this kind necessarily contains a large amount of detail and a formidable array of plant-names. These features of the present little volume are less objectionable when its special purpose is borne in mind, viz., the instruction of gardeners; the various chapters into which it is divided being in fact the substance of a series of lectures delivered to the gardeners at Kew. A reference to these details would be out of place in a short notice; and the best idea will be conveyed by giving the author's final summing up, viz:—That each species has originated from a single centre; that species have originated in different parts of the world, and that the flora of any given tract depends largely on its geographical position; that a large portion of the present genera (or types which agree in structure down to minute detail) were in existence before the end of the Secondary period, and have passed through the very great changes in climate and the relative positions of sea and land that have occurred during the Tertiary period; and that species (or types which accord not in structure only, but in vegetative characters—such as shape of leaves and arrangement of flowers) were dispersed in broad outline as at present, before present islands were insulated and the present general dispersion of sea and land worked out. The reader will find in the volume a very large amount of information on these subjects compressed into a small space.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Ocean Circulation

HAVING carefully read Mr. Croll's papers in the *Philosophical Magazine* for September and October, I find in them the full confirmation of my statement that his "crucial-test" argument is based on the assumption of an equilibrium between the Equatorial and the North Atlantic columns; the words "to be in equilibrium" or "in order to equilibrium" being used over and over again to fix this as the essential condition of the computation by which the North Atlantic column is made out to be 3½ feet higher than the Equatorial.

No reference to other passages in Mr. Croll's writings can countervail this fact. I pointed out at Bristol the fallacy it involves, which was at once recognised by Sir William Thomson, General Strachey, and other competent authorities. This fallacy becomes obvious in the following parallel case:—

The specific gravity of Ægean water being to that of Black Sea water as (say) 1029 to 1013, a column of Black Sea water 1,029 feet high would be required to balance a column of Ægean water 1,013 feet high; therefore (on Mr. Croll's assumption of an equilibrium) the level of the Black Sea must be above that of the Ægean in the proportion of 16 feet to 1,013 feet of depth. But that there is *not* an equilibrium between the two columns, is conclusively proved by the deep inflow of Ægean water which always accompanies the surface-outflow of Black Sea water, showing the Ægean column to be the heavier.

Now Mr. Croll has obviously no more right to assume an equilibrium between the North Atlantic and the Equatorial columns, and thereby to deduce from their relative temperatures the higher level of the former, and the consequent impossibility of the thermal circulation as making the poleward upper flow run uphill, than he would have to deduce the excess of level of the Black Sea from its lower salinity, and to assert that an inward underflow of Ægean water is impossible, as tending to raise that level yet higher.

But there is yet another serious error in Mr. Croll's computation, which, even admitting his fundamental assumption, completely invalidates his conclusion. He has entirely omitted the consideration of the *inferior salinity* of the Equatorial column; which, as it shows itself alike at the surface and at the bottom, may be fairly taken as characterising its entire height. This will make a difference *in the opposite direction* of about one foot in 1,026; sufficient, therefore, if the excess in the North Atlantic column extends to a depth of no more than 600 fathoms, to neutralise the whole 3½ feet of elevation which Mr. Croll deduces from relative temperatures.

Mr. Croll is unable to see what the "viscosity" of water has to do with the question. Just this—that it affects his whole doctrine of "gradients." The nearer water is to a "perfect fluid," the less is the gradient required to give it horizontal motion.

If a viscous fluid be drawn from the bottom of one end, *A*, of a long trough *A—B*, its level at *B* will be lowered more slowly than at *A*, and will remain appreciably higher so long as the outflow continues. But in the case of a "perfect fluid" and a slow outflow, the level will practically fall simultaneously along the whole length of the trough *A—B*. I am quite aware that, *mathematically* speaking, the level must be always lower at *A* than at *B*; since there can be no movement of any particle from *B* towards *A*, unless room has been previously made for it. But if the time required for the replacement of each particle by the one next adjacent to it be infinitely small, the excess of reduction at *A* will also be infinitely small.

Now, according to the authorities I previously cited, water approaches so nearly to the condition of a "perfect fluid," that very small differences in its density will suffice (if constantly renewed) to maintain a vertical circulation, *without any appreciable difference in level*. And my position is, that the void created by the slow descent of water chilled by the surface-cold of the Polar area will be so speedily replaced by the inflow of water from the circumpolar area, and this again by inflow from the temperate region, as to produce a continual upper-flow of equatorial water towards the pole, without the gradient which Mr. Croll persistently asserts to be necessary.

I now leave it in the hands, not of Mr. Croll, but of competent authorities in Physics, to decide (1) whether his "crucial test" has the value he himself assigns to it, and (2) whether his doctrine of "gradients" can stand examination by the light now thrown upon it by Mr. Froude's researches. Until some physicist of equal weight with Sir George Airy and Sir William Thomson shall pronounce the doctrine I advocate to be untenable, I shall continue to believe, with Lenz, Arago, and Pouillet, that it is the only one which can account for the phenomena of Deep-sea temperature.

That the temperature of the upper stratum of the ocean is often affected by the Wind-circulation, and is especially thus modified in the North Atlantic, I have repeatedly pointed out. And it is scarcely fair in Mr. Croll, therefore, to continue speaking of the "wind-theory" and the "gravitation-theory" of Ocean Circulation as if they were antagonistic, instead of being not only compatible, but mutually complementary—the wind-circulation being *horizontal*, and the thermal circulation *vertical*.

As, however, Mr. Croll has now advanced so far as to admit that "physicists may differ from him in regard to whether or not the present difference of temperature between the ocean in equatorial and polar regions is sufficient to produce circulation," I am not without hope that in another year or two he may come to accept the Thermal-circulation as a "great fact;" and that he may then make good use of his knowledge and ability in elucidating the shares which are taken by the Wind-circulation and the Thermal-circulation respectively, in the distribution of terrestrial heat.

WILLIAM B. CARPENTER

The Sliding Seat

MOST problems in animal mechanics are of so complicated a character as to be generally referred to direct experiment rather than to mathematical analysis.

In Mr. Wagstaffe's remarks (vol. xii. p. 369) on the analogy which exists between the movements at the sterno-clavicular articulation in rowing, and those permitted by the sliding seat, we have an argument in favour of the latter arrangement. But when the subject is regarded from the point of view assumed by a practical oarsman, the question of actual advantage still remains unanswered.

There are certain preliminaries which must be considered before we can commence to solve the problem, leading to its subdivision into several distinct problems, some of which will prove interesting to the anatomist, some to the mechanician, some to the physiologist. In the following remarks I shall attempt to indicate the preliminaries referred to.

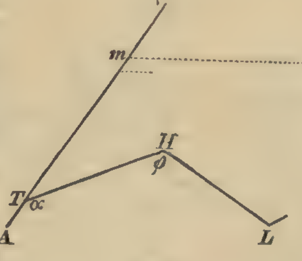
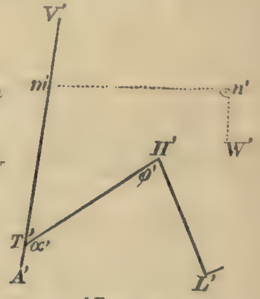


FIG. 1.



[FIG. 2.

Fig. 1 represents the position of the vertebral axis, V A, the thigh, T H, and the leg, H L, when the point A or the seat is fixed.

Fig. 2 exhibits the same parts when A' is movable. In both there is the same position for the outstretched arms, that is, $mn = m'n'$.

It is clear that in 1 the weight, W, will be raised by such forces as tend to move V A towards the vertical position; while in 2 the same result is obtained by changing V' A' without alteration of the angle of inclination. We thus see that the angles α and ϕ will vary in definite inverse ratio, while the variation of ϕ' has almost entirely to be considered in 2. It is this which constitutes the chief difference between the sliding and the fixed seat, and which accounts for the sense of fatigue experienced in the legs in the former system.

If we examine the problems which arise from the consideration of Fig. 1 we shall find that in using the term "fixed seat" we are speaking incorrectly; that is to say, as far as there exists a force to hold A in position we have none but friction; and that practically the position of A with regard to L is determined by muscular action.

Thus in Fig. 2 the seat is really more fixed than in Fig. 1, or there is less muscular action round T′ than round T.

The advantages of the system 2 over 1 are however not simply mechanical, but the constancy of the angle α' affords greater space for the respiratory movements, and thus physiologically there is an explanation for the difference in disturbance of circulation and respiration generally experienced when comparing the two systems. R. J. LEE

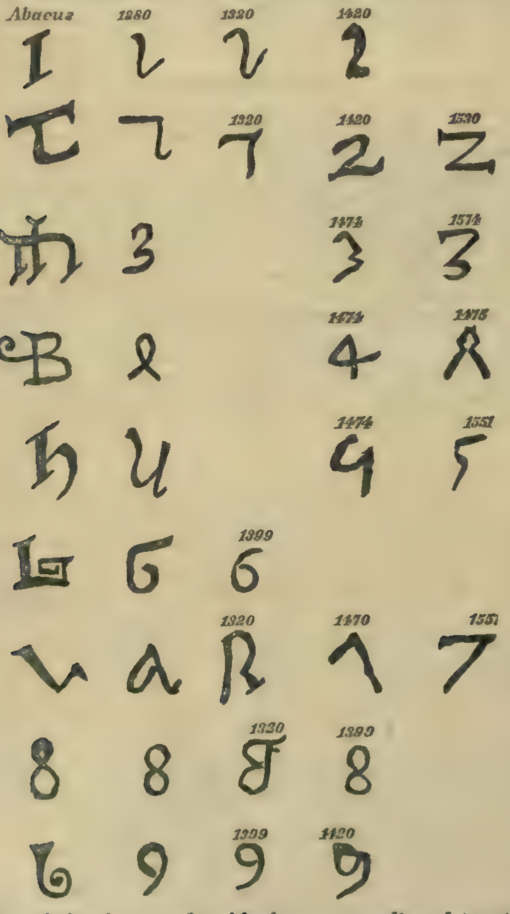
St. George's Hospital

History of the Numerals

ON reading the letter on the "Origin of the Numerals" (vol. xii. p. 476) I was reminded of some portions of their history which I had before noted down, and which are essential to any consideration of their origin.

The earliest forms which I have seen are those of the Abacus (Jour. Archæol. Assoc., vol. ii.), from which our later forms are mainly, if not entirely, derived. The intermediate forms are to be seen in arithmetical treatises and calendars of the thirteenth to sixteenth century, and on sundry quadrants, &c., of the fourteenth to sixteenth century, in the British Museum.

In the following table the earliest form of each letter and of each variation is entered, with the corresponding date; the years 1280, 1320, 1420, and 1450 are only approximately stated.



Now, with respect to the primitive forms suggested by Mr. Donnisthorpe, the 2 would seem to have been two strokes at right angles (not parallel), the lower stroke of our form being only a *tail*, like that of many *medial* forms of Hebrew letters. The 3 may have been originally three vertical strokes, which were set horizontal in early times; the flat top, however, does not appear till 1574, and then only in English examples apparently. The 4 of the Abacus seems to have been deserted for cross lines connected, which are always placed diagonal till about 1474, when the first turn to the present position occurs: perhaps four strokes were intended, as we call cross-roads "four roads meet." 5 seems to have been inverted from the Abacus, and then about 1550 the straight tail was curved towards the previous figure, and the head elongated to lead to the next mark. It often occurs as a perfect though very straightened S in the sixteenth century, as it is now made in Belgium and other countries. Its form in 1280 reminds one of the Roman V written as U. 6 in the Abacus consists of six strokes; but this, from their cumbrous collocation, is probably merely a scribe's fancy. 7 has been apparently inverted (like 5) from the Abacus; its transitions are easily traced, but its origin is not so clear; some might see a trace in the Greek Z = 7. 8 has always been very near its present form, and the two squares is an explanation the character of which can only be objected to on the grounds of its inapplicability elsewhere. 9 has always had a straight tail, though it has been inverted since the Abacus form (as 5 and 7 seem changed): its origin might be looked for in the Greek θ possibly, as that letter has varied more in form than any other; or, more likely, in the Arabic Ta, or Tha (= 9), which in the Abacus it closely resembles; and it is even more similar to the Syriac Teth, a twin form to that of the Arabic. Perhaps the ancient Arabic alphabet (in its nearer approximation to its Hebrew- and Samaritan-like original) would show the origin of more of these forms, and even the simple 1 is exactly the Arabic *Elif* = 1, for their alphabetic origin is rendered highly probable from the fact that the numerical systems of the Greeks and of the Semitic nations (from whom our *Arabic* numerals probably came) were in very early times derived from the alphabet; not, like the Egyptian and Roman systems, wholly separate arrangements.

The apparent, though historically untrue, applicability of the line + line origin of all the forms of our numerals, is an interesting example of the fallibility of any theory which only looks to present conditions, apart from past facts and history.

Bromley, Kent W. M. FLINDERS PETRIE

Scarcity of Birds

I QUITE agree with Mr. Barrington, who writes in NATURE (vol. xii. p. 213) concerning the scarcity of birds. I find, by comparing my last year's ornithological diary with the present year's one, that I have only found about three-fourths of the number of Blackbirds' (*Turdus merula*), Thrushes' (*Turdus musicus*), Blue Titmouses' (*Parus cæruleus*), Pied Wagtails' (*Motacilla alba*), Greenfinches' (*Coccothraustes cloris*), Linnets' (*Linota cannabina*) nests that I found last year. The Hirundinidæ have been far less plentiful than usual; but the Goldfinch (*Carduelis elegans*) was the rarest bird here this summer. I did not succeed in finding a single nest, although our yearly average is fifteen. Other birds, as the Charadriidæ and the Mussel Thrush (*Turdus viscivorus*), have been very plentiful, and I found the Mountain Linnet's (*Linota montium*) nest for the first time I have ever met with it on the lowland south of the Humber. Will not the hard frost of last winter account for the scarcity of our native birds in some measure? ADRIAN PEACOCK

Bottesford Manor, Brigg.

OUR ASTRONOMICAL COLUMN

μ CASSIOPEÆ AND VICINITY.—Smyth (Cycle ii. p. 25) has the following remark with respect to stars near μ Cassiopeæ:—"Just 18′ south of μ is a star which, though of the 6th magnitude, is not in Piazzi. It is followed nearly on the parallel, about 11^s off, by a 9th magnitude, and both are remarkable from being red, of a decided but not deep tint." There is no star of the 6th magnitude near this position at the present time, nor so far as we know is there any record of such an object having been visible since the epoch of Smyth's observations, 1832·71.

It may, however, prove to be a variable star of long period, like the 8th magnitude orange-coloured star remarked by the same observer near Procyon in the autumn of 1833, the existence of which is supported by the observation of Mr. Isaac Fletcher, as described in Smyth's *Sidereal Chromatics* and elsewhere, and we believe by the experience of the Rev. T. W. Webb. There is now a star of the 9th magnitude, following μ Cassiopeæ, 17ˢ·2 and 15′ 38″ south; this is clearly Argelander's star + 53°, No. 228 of the "Durchmusterung," there estimated 9·5, a considerably fainter object than an average 9th magnitude in Bessel's scale; its place would appear to correspond better with that of Smyth's star following his 6th magnitude, nearly on the parallel, than with that of the missing one. Probably this small star may be variable also; its place for the beginning of the present year is R.A. 0h. 59m. 58·3s.; N.P.D., 35° 41′ 27″.

Smyth thought his 6th magnitude star, omitted by Piazzi, might have had "something to do with the mistakes of Flamsteed respecting μ, alluded to by Mr. Baily." These mistakes seem rather to have originated in the confusion of the stars θ and μ, and although Baily doubted if the place of the latter, which he gives from Halley's edition of 1712, could be depended upon, it will be found to agree very well with that of μ carried back from the position in the Greenwich Catalogue of 1860, with Mädler's proper motions.

Should any reader of this column have had the curiosity to look for Smyth's reddish stars, perhaps he will communicate the result of his examination of their neighbourhood.

THE DOUBLE STAR Σ 2120.—Mr. J. M. Wilson has favoured us with the following measures of this star, made at the Temple Observatory, Rugby, by himself and assistants :—

1872·48	Pos.	262°·9	Obs.	4	Dist.	3″·78	Obs.	2
73·50	,,	261°·7	,,	6	,,	3″·65	,,	2
74·62	,,	258°·5	,,	4	,,	4″·2	,,	2

Comparing these measures with the formulæ for rectilinear motion already given in NATURE, the following differences are shown :—

1872·48	Pos. (*c* – *o*)	– 0°·4	Dist. (*c* – *o*)	+ 0″·65
73·50	,,	– 0°·3	,,	+ 0″·91
74·62	,,	+ 1°·8	,,	+ 0″·51

Mr. Wilson has had a suspicion of variation in the magnitude of the companion, but thinks this may be owing to atmospheric circumstances.

THE MINOR PLANETS.—It is notified from Berlin, in M. Leverrier's *Bulletin International*, that the small planet detected by M. Perrotin at the Observatory of Toulouse, on the evening of Sept. 21, in R.A. 23h. 16m. 8s. and N.P.D. 95° 12′, is a new one, and will therefore be No. 149. The brighter members of this group now near opposition are Bellona, Clotho, and Thyra. Clotho will be between the 8th and 9th magnitude; the calculated places are, for Greenwich midnight, as follows :—

			h. m. s.			° ′
Oct. 23	...	R.A.	3 34 47	...	N.P.D.	90 36·0
,, 27	...	,,	3 32 50	...	,,	91 17·0
,, 31	...	,,	3 30 30	...	,,	91 55·8
Nov. 4	...	,,	3 27 51	...	,,	92 31·6
,, 8	...	,,	3 25 0	...	,,	93 3·4

TRANSIT OF COMET 1826 (V.) OVER THE SUN'S DISC.—It was remarked by Gambart that the comet discovered by Pons on the 22nd of October, 1826, the "comet in Bootes," as it was called at the time, must pass over the sun's disc on the morning of November 18, and he was at some pains in correcting the elements of the orbit, with the view of deciding whether the comet had left the disc, before it was examined by himself and Flaugergues, the only two observers who were at stations partially free from cloud on the morning of the transit. A letter from Gambart addressed to Sir John Herschel, at that time president of the Royal Astronomical Society, conveying an intimation of the expected phenomenon, arrived in London on the evening previous to the transit, and, as stated in vol. iii. of the Memoirs of the Society, "the news of so rare a phenomenon was immediately spread, and few astronomers in or near the metropolis failed to be prepared for it;" the sun, however, was totally obscured at rising, and for the whole day, by clouds and rain. A dense fog appears to have prevailed very generally over the continent of Europe, so that, as mentioned above, Gambart at Marseilles and Flaugergues at Viviers alone obtained a view of the disc during the interval in which it was expected the transit would take place.

The following particulars of the transit founded upon a new calculation from the corrected elements of Gambart, closely representing the observations between Oct. 26 and Dec. 11, may possess interest for the astronomical reader.

The comet's true geocentric positions, for Greenwich mean time, were :—

			R.A.		N P.D.
			° ′ ″		° ′ ″
Nov. 17.	17h.	...	233 7 5	...	108 51 48
,,	19h.	...	233 7 52	...	109 11 50
,,	21h.	...	233 8 38	...	109 31 26

Whence, correcting for aberration and taking the sun's places from Carlini's tables, the following differences of R.A. and N.P.D. of comet and sun's centre result :—

	h.		′ ″		′ ″
Nov. 17.	17	Diff. R.A.	+ 5 31	Diff. N.P.D.	– 16 48
,,	18	,,	+ 3 19	,,	– 7 19
,,	19	,,	+ 1 7	,,	+ 2 2
,,	20	,,	– 1 6	,,	+ 11 17
,,	21	,,	– 3 19	,,	+ 20 26

And as referred to the centre of the earth, we find :—

h. m.
Ingress Nov. 17 at 16 59·9 at 19° from sun's N. point towards E.
Egress ,, 20 22·5 at 184° ,, ,, ,,

At Marseilles, the egress would take place at 20h. 59m. apparent time, the equation of time being 14m. 43s. additive to mean time.

As is well known, neither Gambart nor Flaugergues were successful in detecting this comet upon the sun's disc, but though visible at one time to the naked eye, it was not of any considerable degree of brightness.

FAYE ON THE LAWS OF STORMS*

Mechanical Theory of Whirling Movements.—Before we enter on the mechanics of these phenomena, it is necessary to clear the way by the removal of certain ideas which constantly recur to the mind of the reader, and by distracting his attention render any clear unbiassed perception of the subject altogether impossible. This preliminary discussion will embrace the three following points: the part played by electricity in the formation of whirlwinds and cyclones, the significance to be attached to the indications of the barometer, and the part played by currents of aspiration in the modern theory of the trade winds.

1. Part played by Electricity.—Certain physicists, dissatisfied with the views we are about to refute, and struck with the electrical phenomena which so often accompany hurricanes, typhoons, &c., have supposed that electricity is the determining cause. We shall perhaps give a clear idea of this theory by reverting to the electrical explanation of hail, the phenomena of hail being intimately bound up with that of whirling movements. It is well known that hailstones are composed of layers of ice alternately opaque and transparent; in breaking them we see in their texture the evidence of successive and alternate

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* Continued from p. 501.

actions to which they have been subjected. Hence, it is argued, they must have been suspended in the air by some force to allow time for these alternate actions to take effect. Is the force in question not that of electricity? Let us suppose two clouds, superimposed the one above the other, to be charged with opposite electricities; if the crystals of ice which are often to be met with in the upper regions of the atmosphere happen to be in the interval between the two clouds, they will be attracted by the nearest, and thereafter repelled as soon as they have received by contact the electricity with which it is charged. Instantly being attracted by the other cloud, they rush towards it and are immediately charged with the opposite electricity; and this alternate play, during which the hailstones receive successive accretions from the vapour abstracted from the clouds and congealed by the cold of the original hailstone or of the space intervening, will go on till the hailstones acquire a weight too great for them to be any longer suspended, or till an electric discharge has destroyed the opposite electricities which have accumulated on the surfaces of the clouds. At this instant the hailstones fall to the ground by the simple effect of their own weight.

To the same cause the formation of waterspouts has been attributed. Let us suppose a low cloud highly charged with electricity and producing by induction on the water of the sea a powerful accumulation of statical electricity of the opposite sign on its surface. The mutual attraction of these two electricities, the cloud on the one hand, the sea on the other, while powerless to produce contact, will nevertheless give rise to two opposing protuberances in the oppositely electrified bodies. At that point the electricities will acquire a tension the greater as the protuberances continue to assume forms more elongated. As the attractive action goes on increasing, these two protuberances will gradually approach each other between the sky and the earth, and will ultimately unite, the protuberance descending from the sky passing over a greater space than the other. Then, by the conductor thus quickly formed of water and an elongated fragment of cloud, the electricity of the upper regions will escape into the ground, exerting a destructive action over all obstacles in its way. It is also to be noted that the instant when the waterspout is thus completed, thunder ceases to roll in the clouds, the reason being that the electricity has found a silent mode of escape. M. Peltier, the accomplished physicist to whom science is indebted for many ingenious researches on atmospheric electricity, endeavoured to reproduce in miniature the phenomenon thus described; but in bringing a highly electrified conductor close to the surface of a sheet of water, he was unable to show any other sensible mechanical effect than a more rapid evaporation.

We shall not, however, insist on the electrical theory of waterspouts. The theory is now rejected, equally with the electrical theory of hail, because if a few waterspouts have exhibited traces of an electrical action, the greater part of the observed facts show nothing of it. Waterspouts and typhoons are mechanical phenomena, in which electricity plays not the principal part, but a part altogether subordinate. There was a time when the tendency was to explain everything in meteorology by electricity. Whenever any question became obscure, electricity was resorted to as a convenient explanation, and any difficult point was considered as cleared up by an adroit appeal to some laboratory experiment—such as the explanation of the theory of hail from the dance executed by pith-balls between two brass plates. It came, however, to be recognised that, in seeking to identify meteorological phenomena with laboratory experiments, the risk was run of losing sight of the real circumstances of nature and putting in their stead those of the laboratory. The clouds of Volta are real plates of brass, and the spark of the induced conductors, as they are brought near each other, always forgets to manifest itself when the two fragments of waterspouts unite together.

2. Barometer.—The question of the barometer is more difficult. The diminution of pressure which precedes and accompanies cyclones has always been considered as a proof of aspiration. It is certain that the continual lowering of the barometric column—a lowering the maximum of which occurs in the very centre of the hurricane—is a phenomenon so constant as to serve as an infallible warning to sailors. In certain seas and at certain times of the year, the sailor ought to keep his eye on the barometer as much as the compass. But what is the significance of this diminution of pressure? Does it prove that the air over our heads is rarefied? If a vertical column of air was rarefied, the equilibrium would be re-established not at its lower part only, that is to say at the expense of the lower stratum; to effect this, a solid envelope would be necessary to isolate the column through its entire length, leaving only a free opening at its base. But the column, on the contrary, being everywhere in communication with the atmosphere, the equilibrium would be quickly restored by a simultaneous afflux of the strata at all heights, and not merely by the afflux of the lower stratum alone. This, however, is not how things take place. The diminution of the barometer does not indicate a vacuum in the upper regions, but is the result of a movement. Involuntarily, when we speak of the barometer, we always regard pressure in the statical condition, as if the atmosphere was constantly in equilibrium, whilst in reality it is in continual motion. If there was reason to believe that the different layers of air do not mix in crossing each other, it could not be denied that the aqueous vapour in its continual ascent from the ground and the sea does not traverse the successive strata on its way to the more elevated regions of the atmosphere, to be there condensed into minute crystals of ice. And when under the action of other causes, the whole strata of the atmosphere flow almost horizontally, like vast rivers, between strata absolutely immoveable, producing everywhere condensation of vapour and heavy rains, it is doubtful if even the statical principle of the equality of pressure could in every sense be employed; the barometric pressure and its variations ought no longer to be interpreted from the statical point of view only, especially if it arises from gyratory movements on a vast scale. There is here a question belonging to the dynamics of fluids which mathematicians have not yet explained; but in the meantime we ought not to forget the essential distinction between dynamical and statical pressure so as to suppose that every rapid fall of the barometer indicates a sudden rarefaction of air overhead, and consequently aspiration from above downwards.

3. Trade Winds.—The question of the trade winds is connected with the preceding subject. If the air be considered only by itself, it will arrange itself in a state of equilibrium, in homogeneous layers of varying densities, which decrease with the height. These layers will be bounded by ideal level surfaces enveloping the globe, and which may here be regarded as spheres. If the action of the sun, whose heat-rays are specially absorbed by the lowest strata and by the aqueous vapour, is felt more energetically over the torrid zone than in higher latitudes, the inferior strata will expand, and pressing upwards will raise the upper strata to a higher level. The equilibrium being thus disturbed, it will tend to re-establish itself by a general flow towards the coldest regions after the manner of ocean currents, or like immense rivers which have for their beds level surfaces, of which we are about to speak.

On the other hand, the temperate and cold zones receiving this overplus of air, their lower strata taking a movement inverse to the above, set in towards the large space of the equatorial regions where the density of the air is less; and leaving out of view the effects of the earth's rotation, which diverts these currents from the direction of the meridians, we have there the true cause of the trade winds of the high regions, of which the lower trade winds are only the counterpart and the result. The lower trade winds are ordinarily attributed to an equatorial rarefaction and to the indraught which results from it. On this account, the indraught being direct and ceasing with the day, the lower trade winds ought to show, just as sea and land breezes, an alternation from day to night, of which there exists no trace. In considering the trade winds, on the contrary, as the indirect result of the draining effected in the region of the upper strata, we see that the intermediate mass plays the part of the air receiver of a hydraulic machine, which, by annihilating differences of velocity, produces a steady flow, but which placed under the direct action of the motive power would have been intermittent.

The theory of indraught or aspiration represents, on the contrary, vast regular currents of the atmosphere as shown by Fig. 12. We here see at the equator a sort of chimney towards which the air is drawn, and up which it ascends, and thereafter takes a course to north and to south. The proof that matters do not take place altogether in this way, and that the expansion of the air on all sides in the zone most highly heated by the sun does not there upset the order and the statical superposition of the strata, is astronomical refraction, whose laws are the same at the equator as in temperate regions; there is in addition the perfect regularity and the smallness of the barometric oscillations—conditions little compatible with those of a colossal updraught, or even with the behaviour of the trade winds, which no one has ever seen at the confines of the zone of calms begin to assume a vertical direction.

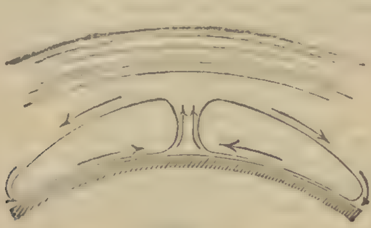

FIG. 12.

If we have at length succeeded in dispelling the idea of vertical aspiration from which has been deduced the direct cause of all aërial currents and all tempests, and the idea of electricity considered as the chief agent in the mechanics of the atmosphere, and lastly the confounding, so frequently, of statical pressure in a fluid mass in repose with dynamical pressure in a medium traversed throughout by movements the most capricious, we shall have no difficulty in accepting the following considerations, for the subject being in this way simplified, the result is a simple question of pure mechanics.

Vortices or Eddies with their Axes vertical to the Current of Water.—If the question exclusively concerned pure mechanics or mathematics, we should be stopped at the very threshold of the inquiry, because mechanics does not yet embrace the study of gyratory movements in liquids or fluids. We have not up to the present moment succeeded in submitting to analysis exact problems of hydrodynamics, unless in very special cases in which we may consider fluids as composed of elements of volume containing always the same molecules, of such sort that their masses are invariable and that the molecules situated at the surface or on any of the sides will always remain at the surface or at the same side. Besides, the trajectories of the liquid filaments ought never to present those re-entering or spiral-like curves which we, however, so frequently remark. If we set out with these restrictive hypotheses, the question cannot be attacked by analysis. In other words, we are forced absolutely to exclude all that relates to the movements with which we are now dealing.

But where analysis is still powerless, experiment and observation remain for our guidance. Whirling movements make their appearance not only in gases; they are equally found in liquids, where they are more manageable, since they can be followed by the eye and even produced at pleasure. We shall therefore commence with the movements which are observed in liquids after we have drawn a vital distinction between the different whirling movements with which we are dealing. Air and water present in fact very complicated gyrations, some ebullient transitory, and without any stability of figure, others' perfectly regular and persistent. They are distinguished by a very simple geometrical figure: the second class have their axis always vertical; the others turn round axes diversely inclined. A moment's reflection will enable us to account for the difference. In the case of a horizontal gyration the spires keep clear of the surrounding layers past which they whirl, or only very slightly graze them in their course. In the first case all motion of the layers disappears; that of the surface even no more exists; because at the surface of separation between the water and the air the eddying spires issue from the liquid mass and cut through or carry away to the interior the air placed above so as to produce the phenomena of spray, froth, foam, and emulsion.

Let us then confine ourselves to whirling movements round a vertical axis, which the student of hydraulics knows and observes, and which can be reproduced at will and studied experimentally. These are, in truth, regular persistent movements which obey laws very simple and precise. The general law which embraces all these phenomena is as follows:—When there exists in a current of water differences of velocity between the filaments in lateral juxtaposition, there tends to be generated, by reason of these inequalities, a regular gyratory movement round a vertical axis. The spires described by the molecules are sensibly circular, with their centres about the axis. These are, speaking more exactly, the spires of a helix, slightly conical and descending, so that in following a molecule in its movements it is seen to turn rapidly in a circle round the axis, which it imperceptibly approaches, descending with a velocity very much less than the linear velocity of rotation. Evidently the centrifugal force which results from this gyratory movement must be everywhere counterbalanced by the pressure of the surrounding liquid; there is then inside these eddying spires, at least at their upper orifice, a slight lowering of the pressure which discloses itself at the surface of the liquid by a feeble conical depression centered about the axis of rotation.

The two following characteristic properties are demonstrated by analysis:—(1) The entire whirl may be regarded as separated from the surrounding fluid, which remains immoveable, by a surface of revolution whose meridian curve has its concavity turned downwards. In other words, the exterior figure of the whirling mass is in the form of an inverted cone pointing downwards. (2) The angular velocity of a molecule increases in proportion as it approaches the axis; it is inversely proportional to the square of its distance from the vertical axis. Hence the linear velocity increases in simple inverse proportion to its distance from the axis. If we consider how great the breadth of the whirling cone in the current of the water occasionally is, relatively to the size of the lower orifice, we shall understand how a gyration which appears sluggish at the surface and at the circumference becomes violent at the base of the funnel-shaped eddy.

These two laws, it must be here observed, are applicable not only to liquids but also to gases. They are easily verified by the experiment of throwing a little dust into water in which an eddy has been formed, when the funnel-shaped figure and circulatory movement of the entire mass and the increase of velocity towards the centre will be at once seen.

The descending movement of these whirls may be examined by the preceding analysis, but observation has long since placed the matter beyond doubt. Everyone knows how much eddies in the current of a river are dreaded by bathers; when a swimmer has the misfortune to be caught in one he is drawn down by a rapid rotation even to the bottom of the water. There, the expert swimmer, knowing how to reserve his strength in place of expending it in useless efforts, extricates himself by resting on the bottom, and, disengaging himself from the eddy, rises quickly to the surface. Not only may men be thus engulphed, but masses of floating ice, or even small vessels, are drawn to the bottom by whirlpools, and thereafter are extricated and rise to the surface only by the obstacle afforded by the bottom, and by the contraction downwards, more and more marked, of the whirling mass of water.

These phenomena can be artificially produced in a large mass of still water, at a part where a rapid movement of gyration is communicated by a suitable mechanical appliance.[*] If we strew dust on the surface, in order to render the phenomena visible, it is seen that gyration is propagated in the form of a cone from above downwards, even to the bottom of the vessel, drawing the dust along with it. Count Xavier de Maistre, who has published in the *Bibliothèque Universelle de Genève* some interesting experiments on this subject, has shown that a layer of oil placed over the water of the funnel-shaped eddy is drawn towards the bottom by a gyratory movement; then, when it comes in contact with the obstacle presented by the base, the oil reascends in globules all round the eddy which it has quitted. There is thus here a double vertical movement—the first regularly descending along the spires of a conical helix, the second ascending and exhibiting in its ascent no geometrical figure, but rising to the surface irregularly *round about* the eddy. It is natural that the liquid thus drawn to the bottom should thereafter ascend more or less, not, be it noted, in the eddy down which it had been carried, but outside it, through the surrounding liquid.

This gyratory movement, which thus concentrates towards the point of the eddy the sum of the moving forces which the funnel-shaped whirl embraces in its vast expanse, ought to produce at its base a certain amount of mechanical work, and observation confirms this idea. The powerful whirlpools of our rivers plough up their beds and thus expend on the soil the force which they have acquired near the surface at the expense of the inequalities of velocity of the general current. And as all currents of water possessing some little depth present like inequalities of velocity among their lateral filaments, on account of the friction of the water against the banks, numerous whirlpools are constantly found whose action consists in finally absorbing these inequalities and regulating the flow of the water, so that the general velocity of the river is perceptibly reduced.

Vortices or Eddies with Vertical Axes in Gases.—All these phenomena are found in gaseous masses traversed by horizontal currents. In currents of this sort, inequalities of velocity will equally give rise to whirling movements round a vertical axis, and, as may be constantly observed, these gyrations will still assume the figure of a truncated cone in an inverted position, which becomes visible when any circumstance occurs to interfere with the transparency of the air. Equally as in the case of water, the gyration of a molecule will be the more rapid the nearer it approaches the centre. The analysis which confirms, or rather explains these phenomena is as applicable to gases as to liquids. Need it be said that waterspouts, from their appearance alone, range themselves in this category? The mechanical identity of whirls formed whether in liquids or in gases is found in all the details—such as the descending movement of waterspouts whose point is seen gradually approaching the earth, and in the abrading force which whirlwinds thus exert on the ground in breaking and beating down objects which obstruct their course—acting thus like a plate fixed perpendicularly at the end of a vertical axis whirling rapidly round. This action evidently ceases when the lower orifice of the waterspout rises a little; it recommences with energy each time that the whirling cone is lowered so as to be brought into contact with any opposing object.

We have only further to prove another characteristic of eddies in a stream of water not less general, in order to complete the study of the analogous phenomena in fluids. At the instant when there is formed in a moving mass of water one of these gyrations which are solely due to inequalities in the general current, it is evident that the eddy thus formed and isolated by an invisible sheath, so to speak, will follow the mean velocity of the current, because nothing can bear away the chief part of the velocity to the molecules which compose the eddy. We shall see it follow the line of the stream, preserving its axis in a vertical position and continuing a longer or a shorter time, or until resistances of every sort have exhausted its force. It will follow the same line of the stream as that taken by a floating object without losing its circular form, and without ceasing to act on the bottom, if it extend so far down, as long as its store of energy is inexhausted.

A distinction must be made between these travelling eddies and the great eddies in deep still water which are ceaselessly formed and re-formed at a post fixed at the turning of narrows of a river. When in such places the current makes itself felt it incessantly bears away with it the spires thus formed; the phenomenon is unceasingly renewed, giving rise to those stationary eddies in rivers which have no analogy to those of the atmosphere, and which appeared to play an important part in deepening the beds of rivers.

(*To be continued.*)

THE LARGE REFLECTOR OF THE PARIS OBSERVATORY

M. WALLON, the French Minister of Public Instruction, presided on the 7th inst. at the sitting of the Council of the Observatory, and at the end of the *séance* he made an official inspection of the large refractor. On the 9th the representatives of many of the Parisian papers were present at the Observatory by invitation of M. Leverrier; the weather, unfortunately, was very tempestuous.

The telescope was left under its iron house, but every detail was carefully explained by M. Leverrier, assisted by M. Wolff, the chief astronomer for physical observations. M. Leverrier praised very highly the skill displayed by the constructors, MM. Eichens and Martin.

The weight of the moveable part is nine tons; the mirror is 120 centimetres in diameter, with a focal distance of 6·80 metres. The weight of the mirror is only half a ton, instead of four tons, which would be necessary for a metallic one; its cost amounts to 2,000*l*.

The telescope is suspended like a refractor in an ordinary equatorial. The ocular is placed in front.

On the 8th minute stars were observed by M. Wolff with a magnifying power of 500, which has been found to answer excellently. An ocular multiplying 1,200 times, and perhaps another, 2,400, will be constructed. A micrometer is being made.

The seeker is in front, and can be rotated with the ocular and the small plane mirror round the axis of the tube by a very simple process. The reason of this arrangement is to facilitate the use of the large iron winding staircase. This enormous metallic structure is moved by special machinery on two circular iron rails. It is always placed on the same side of the tube as the counterpoise, which would render observations impossible if the ocular and seeker were not rotated round the axis of the tube. The height of the iron staircase is about twelve metres, and its weight six tons. The observations are made in open air, and when the weather is propitious the cabin protecting the apparatus is removed by machinery. It is an iron casement (weight twelve tons), moveable on rails. In less than a quarter of an hour the telescope can be directed on any object, however minute.

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[*] These experiments must not be confounded with the experiment of water poured into a vessel to which a movement of rotation round a vertical axis has been communicated. In this case the free surface becomes hollow whilst the water rises along the sides of the vessel. A condition of equilibrium is soon established totally different from the dynamical phenomena we are here discussing. Thus the central depression is parabolical and not conical, and the angular velocity of the fluid molecules is constant, whereas it varies in the movements of eddies in the inverse proportion of the distance from the axis of rotation.

The clock is finished, but not adjusted. The machinery for moving in right ascension is finished and works admirably. The handle and screws for minute motions in declination are finished and working most nicely. So does the gear for connecting and disconnecting the tube with the clock.

The cost of the reflector is 8,000*l.* It was built in six years, but the work was interrupted several times, first by the dismissal of M. Leverrier, secondly by the war and the Commune.

M. Leverrier is justly proud of having completed the large refractor, to which a very few details only are wanting—the adjustment of the clock, the handles for slight equatorial motions, and the machinery for large declination motions. He asked M. Wallon to give orders for the construction of the large refractor, and it was granted at once. A sum of 8,000*l.* has been already voted by the National Assembly for that purpose. It will be seventeen metres in length, and the construction will be completed in three years, if the work is not interrupted by any political or other commotion.

LIEUT. WEYPRECHT ON ARCTIC EXPLORATION

WE have already (vol. xii. p. 460) referred to Lieut. Weyprecht's paper on the Principles of Arctic Exploration, read at the German Scientific and Medical Association. A full report of the paper has now come to hand. Lieut. Weyprecht rightly maintains that the polar regions offer, in certain important respects, greater advantages than any other part of the globe for the observations of natural phenomena—magnetism, the aurora, meteorology, geology, zoology, and botany. He shows that hitherto immense sums have been spent and much hardship suffered for the mere purpose of extending geographical and topographical knowledge, while strictly scientific observations were regarded as holding only a secondary place. While admitting the importance of geographical discovery, he maintains that the main purpose of future Arctic expeditions should be the extension of our knowledge of the various natural phenomena which may be studied with so great advantage in these regions.

After showing in some detail the kind of observations which would yield valuable results, Lieut. Weyprecht lays down the following general propositions:—1. Arctic exploration is of the highest importance to a knowledge of the laws of nature. 2. Geographical discovery in these regions is of superior importance only in so far as it extends the field for scientific investigation in its strict sense. 3. Minute Arctic topography is of secondary importance. 4. The geographical pole has for science no greater significance than any other point in high latitude. 5. Observation-stations are to be selected without reference to the latitude, on account of the advantages they offer for the investigation of the phenomena to be studied. 6. Interrupted series of observations have only a relative value.

Suppose that stations were established at Novaya Zemlya, 76°; Spitzbergen, 80°; West or East Greenland, 76°-80°; N. America east of Behring Strait, 70°; Siberia at the mouth of the Lena, 70°, there would thus be a girdle of observatories around the entire Arctic region. A station in the neighbourhood of the centre of magnetic intensity is much to be desired. By means of the stations already existing in the neighbourhood of the polar circle, a connection would be established with our own region. The cost of one geographical exploring expedition would supply the means of keeping up these stations for a year. The object of these expeditions would be, with similar instruments and according to similar instructions, to record simultaneous observations as far as possible throughout a year. In the first line would be placed the various branches of Physics and Meteorology, as also Botany, Zoology, and Geology; and first in the second line, detailed geographical exploration. Were it possible to establish stations for simultaneous observation in the Antarctic regions, results of much higher value might be expected. Were the cost of these yearly expeditions divided among various countries, it would fall very lightly upon each.

While we think the curiosity of a healthy kind which seeks to know the configuration of the entire surface of our globe, we are sure every man of science will admit the value of Lieut. Weyprecht's propositions. There has, without doubt, been hitherto too much weight attached to merely reaching a high latitude, and too little provision made for strictly scientific observation. Lieut. Weyprecht's suggestions deserve the serious consideration of all civilised countries; were they adopted as a ground for action, a new era in polar exploration would be begun, and results of far higher value than any hitherto obtained might with certainty be expected.

NOTES

IT is rather disappointing that Capt. Young's Arctic Expedition in the *Pandora*, which arrived at Portsmouth on Saturday, should have returned home prematurely without accomplishing any part of the work for which it was organised—the discovery of additional Franklin relics and the complete navigation of the North-west Passage. Under the circumstances, however, Capt. Young has adopted the wisest possible course. Better that the expedition should spend a comfortable winter at home, and set out early next year to renew the attempt in which they have just been baffled. Disco was reached on August 7, Upernivik on the 13th, and Cape York on the 16th, after a splendid passage through the much-dreaded Melville Bay. Carey Islands were visited to deposit letters for the *Alert* and *Discovery* and to obtain a despatch from Capt. Nares, as previously agreed on. The despatch, however, was not discovered till the return voyage. From Carey Islands the *Pandora* proceeded up Lancaster Sound to Beechey Island, which was reached on the 26th. Here Capt. Young inspected "Northumberland House," which was built as a storehouse by the *North Star* (Capt. Saunders) in 1850. It was found that the house had been broken into by bears, and many of the stores damaged, but those in casks and barrels had sustained scarcely any injury. The yacht *Mary* and two lifeboats left by Sir John Ross were in such good condition that, with a few repairs, they could still be made seaworthy. After putting the stores in order, Capt. Young proceeded up Peel Strait for the purpose of reaching King William Land. After considerable manœuvring with the ice, and some difficulties arising from the uselessness of the compasses so near the magnetic pole, La Roquette Island, near Bellot Strait, was reached on August 30. The ground thus far gone over was pretty well known from the explorations of previous expeditions, and Capt. Young was close to his former encampments when travelling from the *Fox* in 1859. But now an impenetrable pack of ice across the channel barred all further progress, and after vainly trying to find a passage, Capt. Young prudently determined to retreat, which he did on Sept. 3. Carey Islands were reached on Sept. 11, and Capt. Nares' record discovered. The *Pandora* arrived at Disco on the 20th, passed Cape Farewell on Oct. 2, and, as we have said, reached Portsmouth on Saturday. Both on the outward and return voyage very rough weather was encountered, although after leaving Disco until Bellot Strait was reached, the weather was on the whole very favourable. The following is Capt. Nares' record referred to :—"H.M.S. *Alert*, at Carey Islands, 3 A.M., 27th July, 1875.—*Alert* and *Discovery* arrived here at midnight, and will leave at 6 A.M. for Smith's Sound, after depositing a depot of provisions and a boat. We left Upernivik on the evening of the 22nd inst., and Brown Islands on the evening of the 23rd. Passing through the middle ice during a calm, we arrived at Cape York on the 25th inst. The season is a very open one, and we have every prospect of attaining a high latitude. All are well on board each ship." Thus the latest news from our Arctic Expedition is entirely favourable.

Two long letters from Mr. Stanley, the leader of the *Daily Telegraph* and *New York Herald* African Expedition, appear in the *Telegraph* of Friday and Monday last. As might be expected, they are full of interest, and contain many geographical details, too summarily stated, however, to be condensed intelligibly, or appreciated without a special map. Such a map Mr. Stanley seems to have sent home, and we hope it will be published as soon as practicable. Both letters are written from the "village of Kagehyi, district of Uchambi, country of Usukuma, on the Victoria Niyanza" (so he spells the name), dated March 1 and May 15 respectively. An intervening letter has not come to hand. The lake was reached after a march of 720 miles from the coast, in 103 days. That the expedition has had to encounter more than the usual difficulties and hardships of African exploration may be inferred from the fact that Stanley has lost considerably more than half his men, including two of his white companions, Frederick Barker and Edward Pocock. Disease carried off the greater number, though many were lost in a fierce fight with the Waturu, a people of the Leewumbu Valley. The principal additions to our knowledge made so far by the determined leader of the expedition is a pretty full account of the country and the people from Western Ugogo northwards to Nyanza, and a survey of over 1,000 miles of the shores of the lake, which apparently is studded with islands. The Shemeeyu River, known by other names in the upper part of its course, which Stanley seems mainly to have followed, and which he regards as the chief tributary of the Nyanza, enters the lake at the village of Kagehyi. Stanley calculates its length roughly at 350 miles. At 400 miles from the coast he came upon the base of the watershed of a number of streams which feed the river, and which he evidently regards as at least one of the Nile sources. According to Stanley's observations, and they seem to have been carefully made, as computed by Capt. George, the height of the Nyanza above sea-level is 3,740 feet—68 feet higher than Speke made it out to be. He has made some other corrections on Speke's observations, especially in the matter of latitude. Speke he makes out to be fourteen miles wrong in his latitude along the whole of the coast of Uganda. The mouth of the Katonga, for example, which in his map is a little south of the equator, Stanley makes by meridian altitude to be in N. lat. 0° 16′. We sincerely hope the indomitable leader of this expedition will be able successfully to accomplish the large task he has set before him—the exploration of the whole of the lake region of Central Africa.

PROF. FAWCETT's address at the opening of the winter session of the Birmingham and Midland Institute on Monday was, as might be expected, instructive and impressive. The tone of it was mainly that of our article last week on the Yorkshire College of Science, that the object of education should be to develop an intelligence which will be cultured all round, and which may be applied to any work in life. Prof. Fawcett spoke mainly of elementary education and of the education which the working classes may obtain in such an institution as the Birmingham and Midland. He advocated the study of botany and political economy from a disciplinary and practical point of view, and very properly discouraged the notion that a good education ought necessarily to make anyone discontented with his position; it would simply dignify labour of all kinds, and make the life of the artisan brighter and nobler. A somewhat similar tone as to what middle-class education should be, and what a college or middle-class school should be, pervaded the address of the Dean of Durham at the opening of the fifth session of the Newcastle College of Science. In an efficient curriculum science will find its proper place, withal a place of the highest importance.

THE Organising Committee for the International Exhibition of Electricity has held its first general meeting at the Palais de l'Industrie, Paris, under the presidency of Colonel Laussedat, one of the delegates appointed by the French Minister of War. The committee approved the regulations proposed by Count Halley d'Arroz, the originator of the scheme, appointed him general director, and divided the exhibition into eighteen groups. Amongst these are the History of Electricity, a section in which will be collected, as far as possible, the instruments which were used by Davy, Faraday, Volta, Arago, Ohm, Oerstedt, Ampère, and others, in making their discoveries. The eighteenth group will be Bibliographical; a library as complete as possible will be formed of all the books and papers published in the Transactions of the several Academies, and scientific periodicals relating to electricity. A requisition will be sent to the administration of the National Library, asking them to offer, for 1877, their Systematic Catalogue of Electricity. The President of the French Republic will be the head of the Committee of Patronage, and a sub-committee has received instructions to open negotiations with foreign *savants* and Governments.

THE catalogues of the various departments under the Science and Art Department at South Kensington have long been noted both for the extent and accuracy of the information contained in them, as well as for the low price at which they may be obtained. It is with pleasure we note that the catalogues of the contents of the Bethnal Green branch are not behind those of the mother institution in point of detail and careful working out. That relating to the special collection of waste products brought together by Mr. P. L. Simmonds is before us, and we recommend all those who are interested in the subject to obtain this little book, which costs only threepence and contains a fund of information on various matters connected with products of the vegetable, animal, and mineral kingdoms. The usual sequence of the three kingdoms of nature is somewhat altered here, the vegetable products being placed first, and for this reason, that "vegetable products have given more extensive and profitable employment and results, in the utilisation of formerly wasted substances and the recovery of residues from manufactures, than either animal or mineral substances." Nothing is too small or unimportant to rescue from simple destruction if it can be turned in any way to serve the purpose of man. As an illustration we may mention the fact of the application as fire-lighters of the central portion of the ear of the Indian corn after the seeds have been taken out; also of the cones of the Scotch Fir (*Pinus sylvestris*), which are sold in France under the name of *Allumettes des Landes*. These are novel applications of what would otherwise be pure waste substances; but there are others which, though waste from one manufacture, are used to adulterate others. From vegetable marrow, melon, and other cucurbitaceous seeds, many of the so-called sugared almonds of the confectioners are made. In China, the seeds of the water-melon are very largely used as food; they are carried from place to place in junks laden entirely with them; they contain a quantity of oil of a sweet or bland nature. In the manufacture of olive oil, much more economy is exercised than was formerly the case. In the olive-growing countries the pulpy portion of the fruit, which was formerly thrown away after being pressed, is now bought up at the rate of from thirteen to sixteen shillings per ton, and submitted to chemical action and powerful steam pressure, by which means about twenty per cent. more oil is obtained. This oil is of course of an inferior quality to that obtained from the first expression. After this remaining oil is extracted, the seeds, which are crushed in the process, are finally burnt as fuel or used as manure. The foregoing notes will show the kind of matter dealt with in the Official Catalogue of Waste products.

FROM the Report, dated June 1875, of Mr. George King, Superintendent of the Calcutta Botanical Gardens, we see that during the past year many important improvements have been effected in the Gardens. Among other things a fine raised terrace has been constructed, on which a large new plant-house is now being erected. This noble conservatory, when finished, will, it is expected, be the greatest addition to the Garden which has been made for years, and will give facilities for the cultivation of delicate plants hitherto unknown in Calcutta. This building is 200 feet in length by 66 feet broad. The collections in the two orchid houses and in the other conservatories have been much increased during the year, considerable additions having been received from Sikkim, the Khasi Hills, the Andamans, and Burmah, also a few plants from the Neilgherries. A number of plants were also sent to the Garden by Mr. Lister, the second gardener, who accompanied the Duffla field-force as a botanical collector. "But," Mr. King justly remarks, in reference to this, "when the floral wealth of Assam, of Eastern Bengal, and of Burmah is considered, not to mention the west and south of India, the collection in this Garden appears miserably small. In an imperial institution such as this, the natural productions of the whole Indian empire should, as far as the climate will permit, be represented. I see no way of forming such a typical collection until a good trained European collector be attached permanently to the establishment. At present I have to rely for supplies of plants from distant parts of India on correspondence with private parties, who, although usually very willing to help, are unfortunately often unskilled in botany or gardening, and neither know what plants to send nor how to pack them safely for transit. The only experts, not employed in the Garden, whose services I can command for collecting, are the manager of the Cinchona plantation and his assistants, and their efforts are of course confined to Sikkim. Had I a collector as one of the regular garden staff, I could send him about to distant districts of which the flora is little known or poorly represented in the Garden, and the result would be that in a few years a very fine collection might be got together both of living plants in cultivation and of dried specimens in the Herbarium. Another great advantage would be that this Garden would be put in a position such as it has not hitherto occupied for exchanging plants with similar institutions all over the world. The cost of maintaining such a collector would not be great, and the extremely liberal manner in which the Gardens have been supported by Government during the past year leads me to hope that this desideratum will soon be supplied."

THERE is being printed for the National Library of Paris two volumes of catalogues of French History. The series will be completed in fourteen volumes. There are also being printed two new volumes of the catalogue of Medicine, containing all the théses supported before the several French schools for a number of years. These two volumes will make the catalogue of Medicine complete in four volumes.

WE learn from the *Journal of Botany* that Prof. Kerner, o Innsbrück—to whose valuable contributions to botanical literature we have frequently called attention, especially relating to the distribution of plants as affected by climatal and geological conditions—will shortly succeed the venerable Fenzl as Professor of Botany at the University of Vienna.

A PAPER by Dr. T. Spencer Cobbold has been reprinted from the *Veterinarian* of this month, on the destruction of elephants by parasites, with remarks on two new species of entozoa, and on the so-called earth-eating habits of elephants and horses in India.

MR. SCLATER has issued an appendix to his "Revised List of the Vertebrated Animals in the Zoological Gardens," containing the names of the additions since the year 1871, among the most important of which are the superb series of Rhinoceroses, five species in all; the Chinese Water Deer of Swinhoe; the Mourning Kangaroo; the Red Oven-bird; Bouquet's Amazon, and three fresh species of Cassowary.

THE principal papers in this month's part of Petermann's *Mittheilungen* are: An account of a journey to Patagonia, by Dr. Karl Berg, of the Public Museum of Buenos Ayres, in which particular attention is given to the natural history of the country; "Chinese Travellers of the Middle Ages to Western Asia," by Dr. E. Bretschneider, of Pekin; "Travels on the Araguaya, Brazil, in January 1865," by Dr. Conto de Magalhães; "Contributions to a Knowledge of the Oasis El-Chargeh," with a map, by Dr. G. Schweinfurth; and a short paper, with map, on Weyprecht's survey of the North Coast of Novaya Zemlya in September and October 1872.

THE *Bulletin* of the French Geographical Society for September contains a careful paper by M. Jules Girard on the Elevations and Depressions which have been observed along the coast of France. This part also contains the conclusion of the Abbé Petitot's valuable contribution to the Geography of the Athabaskaw-Mackenzie region of North America, and a paper by M. E. Allain on the Statistics of Brazil.

THE French Government is sending to China a doctor, M. Durand Fardel, in order to study the important question of contagious diseases, and to elucidate the so much vexed question of quarantines.

IN the Health Section of the Social Science Congress, Prof. Wanklyn read a paper on the waters of the Nile, showing the amounts of chlorine and of hardness at different periods. The rise of the Nile commences at the end of May, and lasts through June, July, and August, up to about the middle of September, when the decrease continues till Christmas. From Christmas till May the amount is tolerably constant. Just at the time of the beginning of the rise of the waters the chlorine is 1·8 grains per gallon, but at the time when the Nile has attained its greatest size it is only 0·3 gr., and it remains very little above that proportion to the end of the year. In marked contrast with the variableness of the chlorine is the constancy of the hardness. Prof. Wanklyn's explanation is that the storm-water which adds so much to the bulk of the Nile sweeps over the country without penetrating far below the surface, and such water passing over a country long ago denuded of salt could convey but little chlorine. He thinks that the débris carried down mechanically by the flood-water contains abundance of finely divided carbonate of lime, so that the storm-water would always be saturated by carbonate of lime. Hence the constant hardness. The water which feeds the Nile, apart from the storm-water, contains 1·8 grains per gallon; and it is the accession of storm-water with chlorine that causes the relative reduction. Similar features will probably be found in other large rivers which have a flood period.

During the meeting of the Social Science Congress at Brighton, Mr. Booth threw open for three days his private museum which is in the course of arrangement. He has built on the Dyke Road a spacious hall of brick, lighted entirely from above, and around this are being placed 306 cases which contain groups of birds shot by himself and Mrs. Booth in Britain. There is one point about the fixing of the cases worth mentioning. A framework is constructed about three feet from the wall into which the glazed cases fit. This prevents any damp from the walls, too frequent in museums, and allows of the easy moving of the cases if needed. As these cases are arranged in three tiers only and there is abundance of light, every bird can be well seen, and the width of the hall is sufficient to admit of viewing the groups from different positions. The most important feature next perhaps to the careful stuffing of the birds, is the fidelity with which the characters of the habitat are reproduced. With birds which change their plumage during the year, two, and where needed, three illustrations are given each with the proper *entourage*. As a collection illustrating our British birds in their native haunts, this is probably unique. There is no attempt at zoological classification, however, since the position of the cases is influenced rather by their relative size and the general picturesque effect of the hall. Whoever the taxidermist is, the collection does him great credit. It is stated that when complete the collection will be thrown open to the public for the benefit of the local charities.

The observations obtained by Prof. Violle (referred to last week, p. 527) in reference to the solar temperature, were obtained not by ballooning, but by the actual ascent of the Alps.

Under date Oct. 19, the *Times* Paris correspondent states that an earthquake which lasted several seconds is reported as having been felt at Moutiers-et-Brides-les-Bains, near Chambery. This phenomenon coincided with great barometrical depression. Snow has fallen on the mountains of the Puy de Dôme.

Dr. Pietre Sancta has just started a new French periodical, the *Journal d'Hygiène*, with the object of realising, as far as possible, in France the ideal of a "city of health." The journal also treats of climatology, mineral waters, wintering and seaside resorts, and kindred subjects.

The pair of Sea-lions which arrived at Brighton last week are, we are informed, specimens of Steller's Sea-lion, about six feet long. The species, which was originally described by G. W. Steller in a work which also contains the account of the huge extinct Manatee-like Rhytina, attains a length of sixteen feet, and has long hair surrounding the neck of the adult male, whence its name. Its under-fur is very little in quantity, so that the skin is of no use for "sealskin."

On Monday the New Ladies' College, known as Newnham Hall, at the back of the Colleges at Cambridge, was formally opened and received into its rooms twenty-seven students. The resident mistress is Miss Clough, the sister of the poet.

A letter in Tuesday's *Times* describes a terrible hurricane and rain and thunder-storm which swept over the island of St. Vincent and other West India islands on the 9th September. In twelve hours the almost incredible quantity of nearly nineteen inches of rain fell.

A course of twelve Gilchrist Lectures, on the Principles of Physical Geography, in connection with the School Teachers' Science Association, is being given at the Foresters' Hall, Wilderness Row, on alternate Friday evenings. The first lecture was given on the 8th inst., and the next will take place tomorrow. The lecturers are Dr. W. B. Carpenter, F.R.S., Mr. J. Norman Lockyer, F.R.S., and Prof. Martin Duncan, F.R.S.

The evening lectures last session in connection with the Yorkshire College of Science were largely attended, and we are glad to see they are to be continued this session. Professors Rucker, Thorpe, and Green are to lecture on special departments of Physics, Chemistry, and Geology respectively, and Mr. L. C. Miall on "The Principal Forms of Animal Life."

The following is the programme of the Glasgow Science Lectures Association for the coming Session:—Nov. 11, "Navigation," by Sir Wm. Thomson, F.R.S.; Nov. 24, "Coals and Coal Plants," by Prof. W. C. Williamson, F.R.S.; Dec. 8, "Recent Researches into the Chemical Constitution of the Sun," by J. Norman Lockyer, F.R.S.; Dec. 22, "Kent's Cavern—its testimony to the Antiquity of Man," by Wm. Pengelly, F.R.S.; Jan. 27, "Mountain Architecture," by Prof. Geikie, F.R.S.; Feb. 16, a lecture by Prof. Huxley, F.R.S., subject not yet announced.

From the thirteenth quarterly report of the Sub-Wealden Exploration, it appears that another effort is to be made to reach a depth of 2,000 feet. The engineer has reported favourably on the possibility of completing that distance by attaching a crown to the 3-inch tubes, and, after boring to 1,824 feet, to recommence with a 2½-inch crown.

The additions to the Zoological Society's Gardens during the past week include two Persian Gazelles (*Gazella subgutturosa*) from Persia, presented by Mr. Archibald Gray; a Ruddy Ichneumon (*Herpestes smithii*) from India, presented by Mr. W. R. Best; a Common Kestrel (*Tinnunculus alaudarius*), European, presented by Mr. J. H. Willmore; a Golden-crowned Conure (*Conurus aureus*) from S.E. Brazil, presented by Col. McArthur; two Crested Porcupines (*Hystrix cristata*), two Servals (*Felis serval*) from S. Africa, a Scarlet Ibis (*Ibis rubra*) from Para, a Common Boa (*Boa constrictor*) from S. America, deposited; a Derbian Wallaby (*Halmaturus derbianus*) born in the Gardens.

A CITY OF HEALTH*

II.

The warming and ventilation of the houses is carried out by a common and simple plan. The cheerfulness of the fireside is not sacrificed; there is still the open grate in every room, but at the back of the fire-stove there is an air-box or case which, distinct from the chimney, communicates by an opening with the outer air, and by another opening with the room. When the fire in the room heats the iron receptacle, fresh air is brought in from without, and is diffused into the room at the upper part on a plan similar to that devised by Capt. Galton.

As each house is complete within itself in all its arrangements, those disfigurements called back premises are not required. There is a wide space consequently between the back fronts of all houses, which space is, in every instance, turned into a garden square, kept in neat order, ornamented with flowers and trees, and furnished with playgrounds for children, young and old.

The houses being built on arched subways, great convenience exists for conveying sewage from, and for conducting water and gas into, the different domiciles. All pipes are conveyed along the subways, and enter each house from beneath. Thus the mains of the water-pipe and the mains of the gas are within instant control on the first floor of the building, and a leakage from either can be immediately prevented. The officers who supply the commodities of gas and water have admission to the subways, and find it most easy and economical to keep all that is under their charge in perfect repair. The sewers of the houses run along the floors of the subways, and are built in brick. They empty into three cross main sewers. They are trapped for each house, and as the water supply is continuous, they are kept well flushed. In addition to the house flushings there are special openings into the sewers by which, at any time, under the direction of the sanitary officer, an independent flushing can be carried out. The sewers are ventilated into tall shafts from the mains by means of a pneumatic engine.

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* An Address by Dr. B. W. Richardson, F.R.S., at the Brighton meeting of the Social Science Association. Revised by the author. Concluded from p. 525.

The water-closets in the houses are situated on the middle and basement floors. The continuous water supply flushes them without danger of charging the drinking water with gases emanating from the closet; a danger so imminent in the present method of cisterns, which supply drinking as well as flushing water.

As we walk the streets of our model city, we notice first an absence of places for the public sale of spirituous liquors. Whether this be a voluntary purgation in goodly imitation of the National Temperance League, the effect of Sir Wilfred Lawson's Permissive Bill and most permissive wit and wisdom, or the work of the Good Templars, we need not stay to inquire. We look at the fact only. To this city, as to the town of St. Johnsbury, in Vermont, which Mr. Hepworth Dixon has so graphically described, we may apply the description Mr. Dixon has written: "No bar, no dram shop, no saloon defiles the place. Nor is there a single gaming hell or house of ill-repute." Through all the workshops into which we pass, in whatever labour the men or women may be occupied—and the place is noted for its manufacturing industry—at whatever degree of heat or cold, strong drink is unknown. Practically, we are in a total abstainers' town, and a man seen intoxicated would be so avoided by the whole community, he would have no peace to remain.

And, as smoking and drinking go largely together, as the two practices were, indeed, original exchanges of social degradations between the civilised man and the savage, the savage getting very much the worst of the bargain, so the practices largely disappear together. Pipe and glass, cigar and sherry-cobbler, like the Siamese twins, who could only live connected, have both died in our model city. Tobacco, by far the most innocent partner of the firm, lived, as it perhaps deserved to do, a little the longest; but it passed away, and the tobacconist's counter, like the dram counter, has disappeared.

The streets of our city, though sufficiently filled with busy people, are comparatively silent. The subways relieve the heavy traffic, and the factories are all at short distances from the town, except those in which the work that is carried on is silent and free from nuisance. This brings me to speak of some of the public buildings which have relation to our present studies.

It has been found in our towns, generally, that men and women who are engaged in industrial callings, such as tailoring, shoe-making, dress-making, lace-work and the like, work at their own homes amongst their children. That this is a common cause of disease is well understood. I have myself seen the half-made riding-habit that was ultimately to clothe some wealthy damsel rejoicing in her morning ride, act as the coverlet of a poor tailor's child stricken with malignant scarlet-fever. These things must be in the ordinary course of events, under our present bad ordinary system. In the model city we have in our mind's eye, these dangers are met by the simple provision of workmen's offices or workrooms. In convenient parts of the town there are blocks of buildings, designed mainly after the manner of the houses, in which each workman can have a work-room on payment of a moderate sum per week. Here he may work as many hours as he pleases, but he may not transform the room into a home. Each block is under the charge of a superintendent, and also under the observation of the sanitary authorities. The family is thus separated from the work, and the working man is secured the same advantages as the lawyer, the merchant, the banker now possesses: or, to make the parallel more correct, he has the same advantage as the man or woman who works in a factory and goes home to eat and to sleep.

In most towns throughout the kingdom the laundry system is dangerous in the extreme. For anything the healthy householder knows, the clothes he and his children wear have been mixed before, during, and after the process of washing, with the clothes that have come from the bed or the body of some sufferer from a contagious malady. Some of the most fatal outbreaks of disease I have met with have been communicated in this manner. In our model community this danger is entirely avoided by the establishment of public laundries, under municipal direction. No person is obliged to send any article of clothing to be washed at the public laundry; but if he does not send there he must have the washing done at home. Private laundries that do not come under the inspection of the sanitary officer are absolutely forbidden. It is incumbent on all who send clothes to the public laundry from an infected house to state the fact. The clothes thus received are passed for special cleansing into the disinfecting rooms. They are specially washed, dried, and prepared for future wear. The laundries are placed in convenient positions, a little outside the town; they have extensive drying grounds, and, practically, they are worked so economically, that home-washing days, those invaders of domestic comfort, are abolished.

Passing along the main streets of the city we see in twenty places, equally distant, a separate building surrounded by its own grounds—a model hospital for the sick. To make these institutions the best of their kind, no expense is spared. Several elements contribute to their success. They are small, and are readily removeable. The old idea of warehousing diseases on the largest possible scale, and of making it the boast of an institution that it contains so many hundred beds, is abandoned here. The old idea of building an institution so that it shall stand for centuries, like a Norman castle, but, unlike the castle, still retain its original character as a shelter for the afflicted, is abandoned. The still more absurd idea of building hospitals for the treatment of special organs of the body, as if the different organs could walk out of the body and present themselves for treatment, is also abandoned.

It will repay us a minute of time to look at one of these model hospitals. One is the *fac simile* of the other, and is devoted to the service of every five thousand of the population. Like every building in the place, it is erected on a subway. There is a wide central entrance, to which there is no ascent, and into which a carriage, cab, or ambulance can drive direct. On each side the gateway are the houses of the resident medical officer and of the matron. Passing down the centre, which is lofty and covered in with glass, we arrive at two side-wings running right and left from the centre, and forming cross-corridors. These are the wards: twelve on one hand for male, twelve on the other for female patients. The cross-corridors are twelve feet wide and twenty feet high, and are roofed with glass. The corridor on each side is a framework of walls of glazed brick, arched over head, and divided into six segments. In each segment is a separate, light, elegant removable ward, constructed of glass and iron, twelve feet high, fourteen feet long, and ten feet wide. The cubic capacity of each ward is 1,680 feet. Each patient who is ill enough to require constant attendance has one of these wards entirely to himself, so that the injurious influences on the sick, which are created by mixing up, in one large room, the living and the dying; those who could sleep, were they at rest, with those who cannot sleep because they are racked with pain; those who are too nervous or sensitive to move, or cough, or speak, lest they should disturb others; and those who do whatever pleases them; these bad influences are absent.

The wards are fitted up neatly and elegantly. At one end they open into the corridor, at the other towards a verandah which leads to a garden. In bright weather those sick, who even are confined to bed, can, under the direction of the doctor, be wheeled in their beds out into the gardens without leaving the level floor. The wards are warmed by a current of air made to circulate through them by the action of a steam-engine, with which every hospital is supplied, and which performs such a number of useful purposes, that the wonder is how hospital management could go on without this assistance.

If at any time a ward becomes infectious, it is removed from its position, and replaced by a new ward. It is then taken to pieces, disinfected, and laid by ready to replace another that may require temporary ejection.

The hospital is supplied on each side with ordinary baths, hot-air baths, vapour baths, and saline baths.

A day sitting-room is attached to each wing, and every reasonable method is taken for engaging the minds of the sick in agreeable and harmless pastimes.

Two trained nurses attend to each corridor, and connected with the hospital is a school for nurses, under the direction of the medical superintendent and the matron. From this school nurses are provided for the town; they are not merely efficient for any duty in the vocation in which they are always engaged, either within the hospital or out of it, but from the care with which they attend to their own personal cleanliness, and the plan they pursue of changing every garment on leaving an infectious case, they fail to be the bearers of any communicable disease. To an hospital four medical officers are appointed, each of whom, therefore, has six resident patients under his care. The officers are called simply medical officers; the distinction, now altogether obsolete, between physicians and surgeons being discarded.

The hospital is brought, by an electrical wire, into communication with all the fire-stations, factories, mills, theatres, and other important public places. It has an ambulance always ready to be sent out to bring any injured persons to the institution. The ambulance drives straight into the hospital, where a bed of the same height on silent wheels, so that it can be moved without vibration into a ward, receives the patient.

The kitchens, laundries, and laboratories are in a separate block at the back of the institution, but are connected with it by the central corridor. The kitchen and laundries are at the top of this building, the laboratories below. The disinfecting-room is close to the engine-room, and superheated steam, which the engine supplies, is used for disinfection.

The out-patient department, which is apart from the body of the hospital, resembles that of the Queen's Hospital, Birmingham: the first out-patient department, as far as I am aware, that ever deserved to be seen by a generous public. The patients waiting for advice are seated in a large hall, warmed at all seasons to a proper heat, lighted from the top through a glass roof, and perfectly ventilated. The infectious cases are separated carefully from the rest. The consulting rooms of the medical staff are comfortably fitted, the dispensary is thoroughly officered, and the order that prevails is so effective that a sick person, who is punctual to time, has never to wait.

The medical officers attached to the hospital in our model city are allowed to hold but one appointment at the same time, and that for a limited period. Thus every medical man in the city obtains the equal advantage of hospital practice, and the value of the best medical and surgical skill is fairly equalised through the whole community.

In addition to the hospital building is a separate block, furnished with wards, constructed in the same way as the general wards, for the reception of children suffering from any of the infectious diseases. These wards are so planned that the people, generally, send sick members of their own family into them for treatment, and pay for the privilege.

Supplementary to the hospital are certain other institutions of a kindred character. To check the terrible course of infantile mortality of other large cities—the 76 in the 1,000 of mortality under five years of age, homes for little children are abundant. In these the destitute young are carefully tended by intelligent nurses; and mothers, while following their daily callings, are enabled to leave their children under efficient care.

In a city from which that grand source of wild mirth, hopeless sorrow and confirmed madness, alcohol, has been expelled, it could hardly be expected that much insanity would be found. The few who are insane are placed in houses licensed as asylums, but not different in appearance to other houses in the city. Here they live, in small communities, under proper medical supervision, with their own gardens and pastimes.

The houses of the helpless and aged are, like the asylums, the same as the houses of the rest of the town. No large building for the poor of pretentious style uprears itself; no men badged and badgered as paupers walk the place. Those poor who are really, from physical causes, unable to work, are maintained in a manner showing that they possess yet the dignity of human kind; that, being worth preservation, they are therefore worthy of respectful tenderness. The rest, those who can work, are employed in useful labours which pay for their board. If they cannot find work, and are deserving, they may lodge in the house and earn their subsistence; or they may live from the house and receive pay for work done. If they will not work, they, as vagrants, find a home in prison, where they are compelled to share the common lot of mankind.

Our model city is of course well furnished with baths, swimming baths, Turkish baths, playgrounds, gymnasia, libraries, board schools, fine art schools, lecture halls, and places of instructive amusement. In every board school drill forms part of the programme. I need not dwell on these subjects, but must pass to the sanitary officers and offices.

There is in the city one principal sanitary officer, a duly qualified medical man elected by the Municipal Council, whose sole duty it is to watch over the sanitary welfare of the place. Under him as sanitary officers are all the medical men who form the poor-law medical staff. To him these make their reports on vaccination and every matter of health pertaining to their respective districts; to him every registrar of births and deaths forwards copies of his registration returns; and to his office are sent, by the medical men generally, registered returns of the cases of sickness prevailing in the district. His inspectors likewise make careful returns of all the known prevailing diseases of the lower animals and of plants. To his office are forwarded, for examination and analysis, specimens of foods and drinks suspected to be adulterated, impure, or otherwise unfitted for use. For the conduction of these researches the sanitary superintendent is allowed a competent chemical staff. Thus, under this central supervision, every death and every disease of the living world in that district, and every assumable cause of disease, comes to light and is subjected, if need be, to inquiry.

At a distance from the town are the sanitary works, the sewage pumping works, the water and gas works, the slaughter-houses and the public laboratories. The sewage, which is brought from the town partly by its own flow and partly by pumping apparatus, is conveyed away to well-drained sewage farms belonging to the city, but at a distance from it, where it is utilised on Mr. Hope's plan.

The water supply, derived from a river which flows to the south-west of the city, is unpolluted by sewage or other refuse, is carefully filtered, is tested twice daily, and if found unsatisfactory is supplied through a reserve tank, in which it can be made to undergo forther purification. It is carried through the city everywhere by iron pipes. Leaden pipes are forbidden.

In the sanitary establishment are disinfecting rooms, a mortuary, and ambulances for the conveyance of persons suffering from contagious disease. These are at all times open to the use of the public, subject to the few and simple rules of the management.

The gas, like the water, is submitted to regular analysis by the staff of the sanitary officer, and any fault he may detect which indicates a departure from the standard of purity framed by the Municipal Council is immediately remedied, both gas and water being exclusively under the control of the local authority.

The inspectors of the sanitary officer have under them a body of scavengers. These each day, in the early morning, pass through the various districts allotted to them, and remove all refuse in closed vans. Every portion of manure from stables, streets, and yards, is in this way removed daily and transported to the city farms for utilisation.

Two additional conveniences are supplied by the sanitary scientific work of this establishment. From steam-works steam is condensed, and a large supply of distilled water is obtained and preserved in a separate tank. This is conveyed by a small main into the city, and at a moderate cost distilled water can be supplied for those domestic purposes for which hard water is objectionable. The second sanitary convenience is a large ozone generator. By this apparatus ozone can be produced in any required quantity, and is made to play many useful purposes. It is passed through the drinking water in the reserve reservoir whenever the water shows excess of organic impurity, and it is conveyed into the city for diffusion into private houses for purposes of disinfection.

The slaughter-houses of the city are all public, and are separated by a distance of a quarter of a mile from the city. They are easily removable edifices, and are under the supervision of the sanitary staff. The Jewish system of inspecting every carcase that is killed is rigorously carried out, with this improvement, that the inspector is a man of scientific knowledge.

All animals used for food—cattle, fowls, swine, rabbits—are subjected to examination in the slaughter-house, or in the market, if they be brought into the city from other depots. The slaughter-houses are so constructed that the animals killed are relieved from the pain of death. They pass through a narcotic chamber, and are brought to the slaughterer oblivious of their fate. The slaughter-houses drain into the sewers of the city, and their complete purification daily, from all offal and refuse, is rigidly enforced.

The buildings, sheds, and styes for domestic food-producing animals, are removed a short distance from the city, and are also under the supervision of the sanitary officer; the food and water supplied for these animals comes equally with human food under proper inspection.

One other subject only remains to be noticed in connection with the arrangements of our model city, and that is the mode of the disposal of the dead. The questions of cremation and of burial in the earth have been considered, and there are some who advocate cremation. For various reasons the process of burial is still retained: firstly, because the cremation process is open to serious medico-legal objections; secondly, because, by the complete resolution of the body into its elementary and inodorous gases in the cremation furnace, that intervening chemical link between the organic and inorganic worlds, the ammonia, is destroyed, and the economy of nature is thereby dangerously disturbed; thirdly, because the natural tendencies of the people lead them still to the earth, as the most fitting resting-place into which, when lifeless, they should be drawn.

Thus the cemetery holds its place in our city, but in a form much modified from the ordinary cemetery. The burial-ground is artificially made of a fine carboniferous earth. Vegetation of rapid growth is cultivated over it. The dead are placed in the earth from the bier, either in basket-work or simply in the shroud; and the monumental slab, instead of being set over or at the head or foot of a raised grave, is placed in a spacious covered hall or temple, and records simply the fact that the person commemorated was recommitted to earth in those grounds. In a few months, indeed, no monument would indicate the remains of any dead. In that rapidly-resolving soil the transformation of dust into dust is too perfect to leave a trace of residuum. The natural circle of transmutation is harmlessly completed, and the economy of nature conserved.

RESULTS.

Omitting, necessarily, many minor but yet important details, I close the description of the imaginary health city. I have yet to indicate what are the results that might be fairly predicted in respect to the disease and mortality presented under the conditions specified.

Two kinds of observation guide me in this essay: one derived from statistical and sanitary work, the other from experience, extended now over thirty years, of disease, its phenomena, its origins, its causes, its terminations.

I infer, then, that in our model city certain forms of disease would find no possible home, or, at the worst, a home so transient as not to affect the mortality in any serious degree. The infantile diseases, infantile and remittent fevers, convulsions, diarrhœa, croup, marasmus, dysentery, would, I calculate, be almost unknown. Typhus and typhoid fevers and cholera could not, I believe, exist in the city except temporarily and by pure accident; small-pox would be kept under entire control; puerperal fever and hospital fever would probably cease altogether; rheumatic fever, induced by residence in damp houses, and the heart disease subsequent upon it, would be removed; death from privation and from puerpera and scurvy would certainly cease; delirium tremens, liver disease, alcoholic phthisis, alcoholic degeneration of kidney, and all the varied forms of paralysis, insanity, and other affections due to alcohol, would be completely effaced. The parasitic diseases arising from the introduction into the body, through food, of the larvæ of the entozoa, would cease, and that large class of deaths from pulmonary consumption, induced in less-favoured cities by exposure to impure air and badly-ventilated rooms, would, I believe, be reduced so as to bring down the mortality of this signally fatal malady one-third at least.

Some diseases, pre-eminently those which arise from uncontrollable causes, from sudden fluctuations of temperature, electrical storms, and similar great variations of nature, would remain as active as ever; and pneumonia, bronchitis, congestion of the lungs, and summer cholera would still hold their sway. Cancer, also, and allied constitutional diseases of strong hereditary character would yet, as far as we can see, prevail. I fear, moreover, it must be admitted that two or three of the epidemic diseases, notably scarlet fever, measles, and whooping-cough, would assert themselves, and, though limited in their diffusion by the sanitary provisions for arresting their progress, would claim a considerable number of victims.

With these facts clearly in view, I must be careful not to claim for my model city more than it deserves; but calculating the mortality which would be saved, and comparing the result with the mortality which now prevails in the most favoured of our large English towns, I conclude that an average mortality of eight per thousand would be the maximum in the first generation living under this salutary *régime*. That in a succeeding generation Mr. Chadwick's estimate of a possible mortality of five per thousand would be realised, I have no reasonable doubt, since the almost unrecognised though potent influence of heredity in disease would immediately lessen in intensity, and the healthier parents would bring forth the healthier offspring.

As my voice ceases to dwell on this theme of a yet unknown city of health, do not, I pray you, wake as from a mere dream. The details of the city exist. They have been worked out by those pioneers of sanitary science, so many of whom surround me to-day, and specially by him whose hopeful thought has suggested my design. I am, therefore, but as a draughtsman, who, knowing somewhat your desires and aspirations, have drawn a plan, which you in your wisdom can modify, improve, perfect. In this I know we are of one mind, that though the ideal we all of us hold be never reached during our lives, we shall continue to work successfully for its realisation. Utopia itself is but another word for time; and some day the masses, who now heed us not, or smile incredulously at our proceedings, will awake to our conceptions. Then our knowledge, like light rapidly conveyed from one torch to another, will bury us in its brightness.

> By swift degrees the love of Nature works
> And warms the bosom, till at last, sublim'd
> To rapture and enthusiastic heat,
> We feel the present Deity, and taste
> The joy of God to see a happy world!

THE INTERNAL HEAT OF THE EARTH

PROF. MOHR, of Bonn, has contributed to the *Neues Jahrbuch für Mineralogie*, &c. (1875, Heft 4), a very important paper on the causes of the internal heat of the earth. After indicating some of the objections which may be urged against the Plutonistic theory of the origin of the earth's internal heat, he discusses the data obtained by the thermometric investigation of a boring about 4,000 feet deep, through pure rock salt, at Speremberg, near Berlin.

The proposition from which he starts is as follows:—If the interior of the earth is still fused, then with every increase in depth, as we approach this furnace, a less space must be necessary to produce the same increase of heat. The heat passes outwards by conduction from a smaller into a constantly enlarging sphere, and supposing the conductivity of the materials to be uniform, the temperature of the outer coats of the sphere must gradually diminish in proportion as their volume increases; or, in other words, the increase of heat per 100 feet must become greater and greater in proportion as we descend.

Now the results of the thermometric investigation of the Speremberg boring give the following numbers:—

For a depth of		Increase per 100 feet.
700 feet	15·654° R.	—
900 ,, ...	17·849 ,, ...	1·097
1100 ,, ...	19·943 ,, ...	1·047
1300 ,, ...	21·939 ,, ...	0·997
1500 ,, ...	23·830 ,, ...	0·946
1700 ,, ...	25·623 ,, ...	0·896
1900 ,, ...	27·315 ,, ...	0·846
2100 ,, ...	28·906 ,, ...	0·795
3390 ,, ...	36·756 ,, ...	0·608

The third column is a diminishing arithmetical series of the first order, showing equal differences of 0·050° or $\frac{1}{20}$° R. for every 100 feet. By applying this principle to the gaps left above 700 feet and between 2,100 and 3,390 feet, Prof. Mohr gets the following table of increase of heat for the whole depth:—

Depth.	Increase per 100 feet in depth.
100 to 200 feet	1·35 ° R.
200 ,, 300 ,, ...	1·30 ,,
300 ,, 400 ,, ...	1·25 ,,
400 ,, 500 ,, ...	1·20 ,,
500 ,, 600 ,, ...	1·15 ,,
600 ,, 700 ,, ...	1·10 ,,
700 ,, 900 ,, ...	1·097 ,,
900 ,, 1100 ,, ...	1·047 ,,
1100 ,, 1300 ,, ...	0·997 ,,
1300 ,, 1500 ,, ...	0·946 ,,
1500 ,, 1700 ,, ...	0·896 ,,
1700 ,, 1900 ,, ...	0·846 ,,
1900 ,, 2100 ,, ...	0·795 ,,
2100 ,, 2300 ,, ...	0·745 ,,
2300 ,, 2500 ,, ...	0·695 ,,
2500 ,, 2700 ,, ...	0·645 ,,
2700 ,, 2900 ,, ...	0·595 ,,
2900 ,, 3100 ,, ...	0·545 ,,
3100 ,, 3300 ,, ...	0·495 ,,
3300 ,, 3390 ,, ...	0·445 ,,

and from this series he concludes that at a depth of 5,170 feet the increase will be *nil*, because, as he says, "the end of the increase will come when the last increase of 0·445° R. is absorbed by the deduction of 0·05° R., therefore after $\frac{0\cdot445}{0\cdot05}$ or 8·9 strata of 200 feet, and therefore 1,780 feet deeper than 3,390 feet,* and he adds that even if the diminution of the increase of heat with depth took place at the rate of only $\frac{1}{100}$° R. instead of $\frac{5}{100}$° R., the region of constant temperature would be reached at 13,500 feet.

A similar diminution of the increase of heat with depth was observed in the case of the boring at Grenelle; but here the depth reached was far less, and the diverse character of the rocks passed through caused doubts to be entertained as to the accuracy of the result.†

In these results Prof. Mohr finds a strong confirmation of all the objections that have been urged from other sides against the Plutonistic theory. "The cause of the increasing heat in the interior of the earth," he says, "must lie in the upper strata of the earth's crust. . . . The theory of volcanoes must of course adapt itself to the above results, and the fluidity of the lavas is not a part of the incandescence (no longer) present in the earth, but a local evolution of heat by sinkings which have always been produced by the sea and its action upon solid rocks, as indeed all volcanoes are situated in or near the sea. This local superheating of the volcanic foci contributes greatly to the internal heat of the earth. For the internal nucleus of the earth can lose but little heat outwards on account of the bad conductivity of the siliceous and calcareous rocks, whilst, in the lapse of ages, it must propagate uniformly all the heat-effects of the volcanoes, and thus a constant elevated temperature must prevail in the interior, and therefore we come to the conclusion that increase of heat in the interior of the earth which is everywhere met with is the result of all preceding heat-actions, uniformly diffused by conduction in the internal nucleus of the earth." Further causes of terrestrial heat are, according to Prof. Mohr, the formation of new crystalline rocks from sun-warmed, infiltrated fluids, and also chemical processes such as the evolution of carbonic acid by the contact of oxide of iron with the remains of organisms, the formation of pyrites and blendes by the reduction of sulphates in contact with organic matters, the decomposition of lignite and coal, &c.

SCIENTIFIC SERIALS

THE *Journal of Anatomy and Physiology*, which in future will appear quarterly instead of twice a year, and has two additional editors, both physiologists, Dr. Foster and Dr. Rutherford, contains several important memoirs. The first is by Mr. Frank Darwin, on the primary vascular dilatation in acute inflammation, in which, from a study of the effect of irritants on the web of the frog's foot, he concludes, in opposition to Cohnheim, and in accordance with Schiff, that local irritants produce these effects on vessels by acting on the peripheral terminations of the vaso-motor nerves; that they do *not* cause dilatation by direct paralysis of the tissues of the arteries, and that when the vaso-motor nerves include both inhibitory and constrictor fibres, both are stimulated by them, the attendant alteration in the calibre of the vessel being the result of the victory of the one set over the other.—Mr. F. M. Balfour has an important article on the origin and history of the urinogenital organs of Vertebrates, in which the independent discovery by Semper and himself of the segmental-organ condition of the primitive Wolffian bodies and kidneys in Elasmobranchiata is fully described, and the mode of development of the Mullerian duct explained. The way in which the segmental organs, opening externally in Annelids, have a ductal termination in Vertebrates is discussed. It is analogous to the manner in which the gill-sacs of Petromyzon, opening externally; those of Myxine have a single external orifice. The paper deserves careful perusal.—Dr. Ogston writes on articular cartilage, and illustrates his observations with six plates. After a description of healthy cartilage, the changes developed in scrofulous arthritis and chronic rheumatoid arthritis are discussed. The paper is more pathological than physiological.—Mr. W. H. Jackson and Mr. W. B. Clarke describe elaborately the brain and cranial nerves of the Shark *Echinorhinus spinosus*, from two specimens transmitted from Penzance to the Oxford Museum, to which are appended accounts of the digestive and urogenital organs.—Mr. J. Priestley demonstrates that the so-called corneal cells described by Dr. Thin as being brought into view by the action of saturated caustic potash solution at 110° F. are, in reality, those of the corneal epithelium.—Mr. E. C. Baber repeats Tillmann's observations on the fibrillar nature of the matrix of hyaline cartilage, confirming them, but differing as to the reagents which best demonstrate them.—Prof. Turner has an important memoir on the structure of the diffused, the polycotyledonary, and the zonary forms of placenta, which contains the substance of his course of lectures on that subject at the Royal College of Surgeons last summer.—Prof. Rutherford replies to Mr. Lawson Tait's comments on his freezing microtome, satisfactorily demonstrating the value of the instrument.—Dr. Stirling describes his way of preparing skin for histological examination by the rather crude method of partial artificial digestion.—Finally, Mr. J. N. Langley writes on the action of Jaborandi on the heart, discussing its slowing action, which he was the first to determine.—Dr. Stirling's Report on Physiology concludes the number.

THE current number of the *Quarterly Journal of Microscopical Science* commences with an illustrated memoir, by Mr. D. J. Hamilton, "On Myelitis, being an experimental inquiry into the pathological appearances of the same," in which the effect of traumatic injury of the cord is investigated microscopically.—The second paper is an abridged translation by Dr. W. R. M'Nab, of a paper by Dr. Oscar Brefeld, from his "Botanische Untersuchungen über Schimmelpilze," Heft. II., on the life-history of Penicillium.—This is followed by an article "On the Resting-Spores of *Peronospora infestans*, Mont, by Mr. Worthington Smith, with photographic illustrations.—After this Dr. Klein describes the Structure of the Spleen. He finds "that the pulp of the spleen of the rat and the cat is similar to that of the dog, whereas that of the monkey is similar to that of man; also that in the pulp the matrix, instead of being composed of fine fibres, has the appearance of honey-combed membranes, which only when seen in profile have the appearance of fibres. All the author's observations support the view of the splenic circulation adopted by W. Müller, Frey, and others, that the venous radicles represent merely a labyrinth of spaces in the splenic parenchyma. He agrees with those who find that there is a gradual passage from the matrix of the pulp to that of the adenoid tissue of the arterial sheaths and the Malpighian corpuscles.—Mr. C. H. Golding-Bird describes a simple differential warm stage by which a fairly uniform temperature may be maintained for a long time. To the central copper stage proper are fixed a tongue of copper and an iron wire, round both of which, for part of their extent, bell-wire is wound.—Mr. W. H. Poole describes the effect of the double-staining of tissues with hæmatoxylin and aniline. The nuclei stained by hæmatoxylin are made of a richer colour by the second reagent, whilst the protoplasm surrounding them is much bluer than the nuclei themselves.—Mr. J. M'Carthy makes some remarks on Spinal Ganglia and Nerve-fibres.—Dr. Klein has a note on a Pink-coloured Spirillum (*Spirillum rosaceum*).—The last paper is by Mr. Frank Darwin, on the Structure of the Proboscis of *Ophideres fullonica*, an orange-sucking moth, in which the peculiar conformation of the apex of that organ is described and figured, as is the interlocking of the two halves of its component maxillæ.—Notes, chronicle, and proceedings of Societies complete the number.

THE *Transactions of the Linnean Society of London* will in future be published, like the *Journal*, in two series, Zoological and Botanical. Three parts have recently been issued. The third and concluding part of vol. xxix. completes the account of the Botany of the Speke and Grant Expedition, by Prof. Oliver and Mr. J. G. Baker, and is illustrated by sixty-four plates, making 136 for the whole volume. The first part of the first volume of the second series (Zoology) includes Mr. W. K. Parker's paper On the Skull of the Woodpeckers; Dr. Willemoes-Suhm's, On the Crustacea of the *Challenger* Expedition; and Prof. Allman's, On the structure and systematic position of *Stephanoscyphus mirabilis*, the type of a new order of Hydrozoa: and the first part of the new Botanical series is occupied by Mr. Miers's papers on *Napoleona*, *Omphalocarpum*, *Asteranthos*, and on the Auxemneæ. An account of all these papers was given at the time of their delivery before the Society.

THE *Geological Magazine*, Nos. 133, 134, 135.—The principal original articles are instalments of long articles on volcanoes, by Mr. Judd; on *Cretaceous aperrhaidæ*, by Mr. Starkie Gardner; on meteorites, by Dr. Walter Flight. Carl Pettersen contributes a sketch of the geology of Northern Norway, in No. 135. A list of previous writers is given. Five groups of stratified rocks are recognised: 1. The primitive; 2. The Tromsö mica slate group, probably the equivalent of the Cambrian; 3. Slates of Balsfjord, age very uncertain, perhaps late Cambrian; 4. Alten group, regarded as Silurian; 5. Golda group, Devonian. The groups of the Secondary period are quite unrepresented. Throughout the Quaternary period the land has been subjected to an upheaving of about 120 metres, and this elevation has been continued down to the historic time. As to whether the land is still rising, there is no positive evidence existing. In any case it is certain the elevation during the last thousand years has been insignificant. When it is stated in so many quarters as a geological fact that the northern part of Norway rises about one-third of a metre in a century, this rate is evidently much too great. The unstratified rocks met with are also described. To No. 135 there is a supplement of forty-four pages, containing a report with plates of Mr. Tylor's lecture to the Geologists' Association on denuding agencies.

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* In this calculation Prof. Mohr seems to have made a slight slip. If the increase of heat diminishes at the rate of 0·05° R. per 100 feet, it is hard to see why strata of 200 feet should be taken as the units in the calculation. Taking 100 feet as the unit of space, the zero point should be reached at 4,280 feet.

† See Vogt's "Lehrbuch der Geologie," Bd. I. p. 29.

THE *Proceedings of the Natural History Society of Glasgow*, vol. ii. Part I. contains among the most interesting of its articles a paper by Mr. John A. Harvie Brown on the birds found breeding in Sutherlandshire, and another by the same author in conjunction with Mr. E. R. Alston, F.Z.S., on the mammals and reptiles of the same county. These form an excellent addition to Mr. Selby's on the same subjects.—Mr. J. Gilmour writes on the introduction of the Wild Turkey (*Meleagris gallipavo*) into Argyllshire; as does Mr. D. Robertson on the Sea Anemonies of the shores of the Cumbraes, &c.—Mr. J. Coutts describes the post-tertiary clay-beds at Kilchattan Bay, Isle of Bute.—Mr. R. Gray notes points in the distribution of the Capercaillie in Scotland; on the occurrence of the Crane in Rossshire; on the Wood Pigeon, &c.—Lord Binning gives notes on the food of the Wood Pigeon.—Capt. H. W. Fielden, now naturalist to the Arctic Expedition, writes on the Gaur or Indian Bison, and gives notes on a tour through the Outer Hebrides.—Mr. J. S. Dixon gives notes on the discovery of an ancient canoe at Little Hill, Cadder Moor.—Dr. Grieve records dredging notes from the Bay of Rothesay.—There are other short papers by Mr. W. Galt, Mr. J. Young, Dr. D. Dewer, Prof. A. Dickinson, Mr. J. Ramsey, Mr. D. Robertson, Rev. J. L. Somerville, &c.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Sept. 1.—Mr. Blanford's researches on solar radiation and spots, described in a former number of NATURE, form the subject of the first paper.—In the concluding part of Dr. Theorell's description of his printing meteorograph, he states that, with certain precautions, the instrument may be kept for a long period in good working order. One has been in use at Upsala during the last three years and a half, and has lost nothing of its original precision. In a note appended to the inventor's description, Herr Osnaghi mentions some alterations which have been made in the Vienna instrument; thus the power to register great velocities of wind, in which it was formerly wanting, has been conferred upon it. Since the completion of these alterations the meteorograph has worked constantly and regularly.—In the "Kleinere Mittheilungen" we have an interesting extract from a letter written by Director Hoffmeyer, on the causes of the cold weather in May 1874. Up to the 21st of the month the synoptic charts show a maximum of pressure over N.W. and W. Europe, stretching like a great screen between the Atlantic and Central Europe, from Spitzbergen almost to Algiers, the minima coming partly from the Arctic seas, partly from the Western Mediterranean, with gradients steep towards N. and W. Such a distribution of pressure must give rise to a cold Polar stream flowing over the greater part of Europe. In Vienna the cold was greatest between the 16th and the 18th, and then the high pressure began to travel eastwards. This movement of the maximum produced a great change. The Atlantic minima, instead of moving northwards along the west coast of Greenland as hitherto, now pressed eastwards, reached Iceland and the Azores, and soon the pressure was lowest in the very district where a few days before the maximum existed. At the same time temperature rises in Central Europe. In June a similar succession of barometric changes occurred, and the maximum of pressure in the N. W. was again attended with cold at Vienna. Herr Hoffmeyer observes that areas of high pressure are much more quiet and longer lasting than minima, which travel rapidly, change their shapes, and throw off secondary disturbances. He thinks the present system of averages insufficient for the purposes of generalisation, and regards the researches of Köppen on the properties of winds in different conditions of atmospheric distribution as a step in the right direction.

THE July number of the *Bulletin Mensuel de la Société d'Acclimatation de Paris*, which is always more than a month behind date, opens with the Secretary's Annual Report on the proceedings of the Society in 1874.—Special attention has been given to the training of wild animals, such as zebras, for domestic purposes, and to the breeding of hybrids, such as those between the horse and zebra, ass and zebra, &c. Complete success is said to have attended the attempts to tame the zebras in the Gardens of the Society. The efforts of the Society are largely assisted by the experiments carried out by such gentlemen as M. Cornély, M. Mairét, M. Moreau, and others, who have succeeded in rearing many of the rarer forms of foreign animal life, and useful plants.—New Caledonia is the subject of a lengthy paper by M. Germain, who considers that that country would easily support many useful animals which do not exist there. By their introduction the country would be greatly benefited, while its importance would also be increased by additional facilities being given for utilising its indigenous produce. It is peculiarly rich in timber, which affords shelter to many kinds of useful birds.—The cultivation of the Alfa Plant (*Stipes tenacissima*), which grows wild in Algeria, is strongly recommended in the South of France, where there are large tracts of land well suited to its growth.—The cultivation of new varieties of silkworms is steadily progressing in France, and the improved breeds which have been introduced have greatly assisted in remedying the evils of the silkworm disease.

THE *Schriften der Naturforschenden Gesellschaft in Danzig* (vol. iii. heft 3).—From this publication we notice the following papers:—Researches on the Prehistoric Times of West Prussia, by Dr. Lissauer.—On the Petrefacts found in the Diluvial Deposits near Danzig, by Herr Conventz.—On the Culture of the Caterpillars of *Gastropacha pini*, by G. Brischke.—On a Humming *Acilius sulcatus*, by the same.—Report on the investigations of Antiquities made in the neighbourhood of Neustettin during 1873, by Major Kasiski.—On the Spiders of Prussia, (seventh treatise), by A. Menge, with tables. This paper is the most valuable one in the publication, and gives proof of the wonderful diligence and energy of its author.

La Belgique Horticole, September and October.—In the current number of this magazine, usually devoted almost entirely to horticulture, are several articles of more than common interest. The paper of De Candolle's is reprinted entire which has attracted a good deal of attention, on the different effects on the growth of the same species of the same temperature in different latitudes. Prof. E. Morren, the editor, has two articles on the "carnivorous" habits of *Pinguicula* and *Drosera*. Following Mr. Darwin's lead in a careful series of experiments on two Alpine species of the former genus, *P. alpina* and *longifolia*, and the common *D. rotundifolia* of the latter genus, he finds the same results as regards the secretion of a fluid which causes rapid decay of the substances in contact with it, but is not prepared to admit any process of actual digestion or assimilation on the part of the plant. M. Ch. Royer has also an interesting note on the cause of the sleep of plants.

SOCIETIES AND ACADEMIES

LEEDS

Naturalists' Field Club and Scientific Association, September 15.—Mr. Henry Pocklington, F.R.M.S., in the chair.—Mr. James Abbott exhibited a number of interesting plants collected in the West Riding, including *Potentilla norvegica*, which grows abundantly on the banks of the Leeds and Liverpool Canal between Armley and Kirkstall, and appears to have been thoroughly naturalised. It was first gathered about 1860, by Mr. Wm. Kirkley, but not satisfactorily determined at the time. In 1868 it was found, also apparently native, in Burwell Fen, Cambridgeshire, by Mr. G. S. Gibson, and recorded by him in the *Journal of Botany* for that year (vol. vi., p. 302; also see "Babington's Manual," seventh edition). In 1874 Mr. Abbott noticed it in great abundance, and in 1875 it was sent to Kew to be named. It turned out to be a Scandinavian form, though in what manner it reached the Leeds district is as yet unaccounted for. Mr. C. P. Hobkirk, of Huddersfield, reports that it grows on the canal banks in his neighbourhood, where he found it in 1873. Mr. Abbott also reported the capture of the Clouded Yellow Butterfly (*Colias edusa*) near Adel Dam, six miles north of Leeds, on the 5th September. This ordinarily southern form seems this year to have extended its range far to the northward. *Vanessa antiopa*, also recorded from Kirkstall Road, Leeds, in September.

Paris

Academy of Sciences, Oct. 4—M. Frémy in the chair. The following papers were read:—On the Observatory of the Office of Longitudes at Montsouris, by M. Mouchez.—On the dredging of the roadstead of Port Said, second note by M. de Lesseps.—New researches on beats of the heart in the abnormal state, and on the registration of these beats and of those of the arteries, by M. Bouillaud.—On disordered variation of hybrid plants, and deductions which may be made from it, by M. Naudin.—On the carpellary theory, according to the Irideæ, by M. Trecul.—Results of observations of solar protuberances and spots, from 23rd April to 28th June, 1875 (fifty-five rotations), by P. Secchi. Four tables are given; deductions to follow.—On the *Hemisepius*, new genus of the family of Sepians, with some remarks on species of the genus *Sepia* in general, by M. Steenstrup.—Results obtained from attempts at industrial applications of solar heat, by M. Mouchot. The apparatus (in work at Tours) consists of a silver plate mirror, in form of a truncated cone, turning with the sun; a cylindrical annular boiler at focus, with blackened surface; and a glass envelope admitting the sun's rays, but preventing their exit when transformed into obscure rays. One very hot day, five litres of water were vaporised in the hour, representing 140 litres of steam per minute.—On the mechanical properties of different vapours at saturation in a vacuum, by M. Antoine.—On the different quantities of heat produced by the mixture of olive oil with concentrated sulphuric acid, according as the boiling of the acid is more or less recent, by M. Maumené.—On the existence of ferruginous and magnetic corpuscles in atmospheric dust, by M. Tissandier. Drawings are given.—On the formation of clouds, by M. Hureau de Villeneuve.—On sexualised Phylloxera and the winter egg, by M. Balbiani.—MM. Chablaix, Corteggiani, and Pourcherol, also presented notes on Phylloxera.—M. Marsanne submitted a memoir on "Process and apparatus for production of signals, fires, and electric lights."—M. Malessart presented a second note on the problem of aviation.—M. Tellier called attention to an experimental voyage about to be made to La Plata for transport of meat preserved by cold.—M. Petit presented a note relative to the transformation of starch by diastase, and the production of a new saccharine matter.—The Secretary notified a brochure by M. Cossa, on the syenite of Biellese.—On the eclipse of the sun of 28–29 Sept. 1875, by M. Angot.—On the reduction of a ternary cubic form to its canonic form, by M. Brioschi.—On the value of the coefficient of expansion of steam from superheated water, by M. Croullebois.—Influence of stripping off the leaves on the vegetation of the beet, by M. Violette. It diminishes the root's weight and yield of sugar, increasing the proportion of other matters.—On two new meteorites of the desert of Atacama, and on the meteorites found hitherto in this region of South America, by M. Domeyko.—On clouds of ribbon-form, by M. de Fonvielle.—Observations of a bolide at Couiza (Aude) on the night of 30th Sept. 1875, by M. Amigues.—The thunderstorms of 1875, by M. d'Arbaud-Blonzac.

Oct. 11.—The following papers were read:—Results of observations of solar protuberances and spots from April 23 to June 28, 1875 (55 rotations) concluded, by P. Secchi. The daily number of protuberances and surface of spots steadily diminished. The great metallic eruptions ceased when the large spots disappeared. Two maxima of protuberances in each hemisphere disappeared, leaving only the minima of the equatorial zones. Protuberances diminished in height. Faculæ disappeared from round the poles and were confined to the zone of spots and protuberances.—M. Girardin presented a new edition of his work, "On Dung and other Animal Manures."—M. Favre gave an extract from his memoirs "On the transformation and equivalence of chemical forces."—On the rotatory polarisation of quartz, by MM. Soret and Sarazin.—New note on the processes of magnetisation, by M. Gaugain.—On the formation of hail, by M. Planté. Electricity suddenly brings the water of clouds to a state of extreme division, facilitating congelation in a medium of low temperature. Terrestrial magnetism, or the permanent electric current of the globe, causes the gyratory movement of electrified cloud masses.—Researches on the ammonia contained in sea-water, and in that of salt marshes in the neighbourhood of Montpellier, by M. Andoynaud.—On commercial analysis of sugars, and the influence of salts and glucose on crystallisation of sugar, by M. Durin.—On the hypsometric distribution of living molluscs in the Central Pyrenees, by M. Fischer.—On the necessity of surrounding the lower part of vine-stocks with coal-tarred powders, by M. Girard.—Five other communications relative to Phylloxera.—M. Lehmann presented a further note on a system of propulsion for steamships.—M. Le Breton submitted to the judgment of the Academy various apparatuses for the ascension of liquids.—M. Holzner showed specimens of carrot-roots, bearing pucerons apparently of a new species.—The Director-General of Customs presented a general tableau of the commerce of France with its colonies and foreign powers during 1874.—The Secretary called attention to a memoir by MM. Nobel and Abel on explosives, and one by M. Volpicelli, defending Melloni's electrostatical theory.—Remarks on the use made, in antiquity, of solar heat, on occasion of M. Mouchot's recent note, by M. Buchwalder.—On the electric conductivity, of pyrites, by M. Dufet. This is true metallic conductivity very variable with the physical structure of the specimen, but in a given crystal, depending neither on the direction, the intensity, nor the duration of the current.—On the toxical effects of alcohols of the series $C^{n}H^{2n+2}O$, by M. Rubuteau.—On the new tellurised minerals lately discovered in Chili, by M. Domeyko.—Perforation of a quartzous grit by the roots of trees, by M. Meunier.

BOOKS AND PAMPHLETS RECEIVED

British.—Report of the Meteorological Commission of the Royal Society.—Ganot's Elementary Treatise on Physics. Seventh Edition, Revised and Enlarged. Translated by E. Atkinson, Ph.D., F.C.S. (Longmans).—Ultima Thule; or, a Summer in Iceland: R F. Burton (Nimmo).—Proceedings of the Bath Natural History and Antiquarian Field Club. Vol. iii. No. 2.—Elementary Lessons in Botanical Geography: J. G. Baker, F.L.S. (Reeve).—Numerical Examples in Heat: R. E. Day, M.A. (Longmans,.—Zoology for Students: C. Carter Blake, D.Sc., with Preface by Richard Owen, C.B., F.R.S. (Daldy, Isbister).—Pollution of Rivers: Wm. Hope, V.C.—Food Manufacture *versus* River Pollution: Wm. Hope, V.C.—The *Challenger's* Crucial Test of the Wind and Gravitation Theories of Oceanic Circulation: Jas. Croll.—Notes on some Comparative Microscopic Rock-Structure of some Ancient and Modern Volcanic Rocks; J. Clifton Ward, Assoc. R.S.M., F.G.S. (Taylor and Francis).—A Series of Twelve Maps for Drawing and Examination: Charles Bird, R A., F.R A.S. (Stanford).—Revised List of the Vertebrated Animals in the Zoological Society's Gardens. Supplement.—Medicinal Plants: R. Bentley, F.L.S., and Henry Trimen, M.B., F.L.S. Part I. (Churchill).—Nebraska; its Advantages, Resources, and Drawbacks: Edwin A. Curley (Low, Marston and Co.)—The Dawn of Life: J. W. Dawson, LL.D., F.R.S. (Hodder and Stoughton).—Elementary Analytical Geometry: T. G. Vyvyan, M.A. (Geo. Bell and Sons).—The Botanical Locality Record Club. Report for 1874 (E. Newman).—Elementary Biology: Prof. T. H. Huxley, F.R.S., &c., and H. N. Martin (Macmillan and Co.)

Colonial.—Hybridity and Absorption: Daniel Wilson, LL.D., F.R.S.E. (from the *Canadian Journal*).—Mineral Statistics of Victoria, Australia, for 1874.—Report of the Geology and Resources of the Region and Vicinity of the Forty-ninth Parallel: G. M. Dawson, Assoc. R.S.M., F.G.S.—Transactions of the Royal Society of New South Wales for 1874.—Report on Deep-sea Dredging Operations in the Gulf of St. Lawrence: J. F. Whiteaves.—Reasons suggestive of Mining on Physical Principles for Gold and Coal: J. Wood Beilby (Melbourne: Walker, May and Co.)—Transactions of the Literary and Historical Society of Quebec. New Series, Part II.

American.—Tinnitus Aurium: S. Theobald, M.D. (Baltimore, Innes and Co.)—Bulletin of the Bussey Institution, Boston, U.S. Parts II., III., IV.—Iowa Weather Review, No. 1: Dr. Gustavus Hinrichs.—Report of the Director of the Menagerie, New York.

Foreign.—Boletin de la Academia Nacional de Ciencias Exactas existente en la Universidad de Cordova. Part IV. (Buenos Aires).—De la Nature des Eléments de la Chimie, par J. A. Groshaus (Haarlem, Les Heritiers Loosjes).—N. Sewerzow's Erforschung des Thian-Schan-Gebirgs-Systems, 1867, &c., von A. Petermann (Gotha, Justus Perthes).

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THURSDAY, OCTOBER 28, 1875

SIXTH REPORT OF THE SCIENCE COMMISSION

THREE times within the last twelve years a Royal Commission has reported on the science teaching of our higher schools. In 1864 the Public Schools Commission announced that from the largest and most famous schools of all it was practically excluded. In 1868 the Endowed Schools Commission declared that the majority of school teachers had accepted it as part of their school work. The Science Commissioners of 1875, in their Sixth Report, on Science Teaching in Schools, testing this statement by inquiry, reports that of 128 endowed schools examined by them not one-half has even attempted to introduce it, while of these only 13 possess a laboratory, and only 10 give to the subject as much as four hours a week. And this statement is curiously illustrated by the statistics of the recent Oxford and Cambridge School Examination, which show that out of 461 candidates for certificates from 40 first-class schools, while 438 boys took up Latin, 433 Greek, 455 Elementary Mathematics, 305 History; only 21 took up Mechanics, 28 Chemistry, 6 Botany, 15 Physical Geography.

In a volume whose research and condensation make it not only a monument of conscientious toil, but an invaluable handbook to all who are labouring to work out practically the great problem of which it treats, the Commissioners investigate the obstacles which have caused the endowed schools to defy the weighty recommendations of former Commissions, the unanimous verdict of educational authorities outside the scholastic profession, and the increasingly urgent demands of English public opinion. They find the schoolmasters' excuses to be threefold; absence of funds, want of time, and scepticism as to the educational value of science in comparison with other subjects. A large portion of the Appendix is devoted to the consideration of these difficulties; to sifting the allegations on which they rest, and to balancing against them the experience of those teachers who have faced and successfully met them. Showing in detail the comparatively trifling cost at which indispensable apparatus can be obtained, the Commissioners nevertheless admit the rarity, in the present state of English culture, either of independent science teachers suited to the larger schools, or of men, such as poorer schools desiderate, combining literary with scientific knowledge. This, however, is an evil of the past rather than of the future, since not the least amongst the advantages expected from a reformed system of school teaching is the creation of a race of able teachers, general as well as special. The relative value of science as an implement of mental training is next discussed. Its peculiar excellence is briefly vindicated, as cultivating in a way attainable by no other means the habits of observation and experiment, of classification, arrangement, method, judgment; and its suitability to the capacities of the very youngest boys is testified to by Faraday, Hooker, Rolleston, Carpenter, and Sir W. Thomson. Lastly, it is shown that, if this be so, the argument from want of time is no argument at all; that the hours are already wasted which condemn the half of a boy's faculties to stagnation and render education one-sided and incomplete; and that the claims of different branches of instruction may be easily adjusted by economy of time, improvement in methods, and excision of superfluous studies.

On a review of all these objections and of the answers offered to them, and taking into account the dicta of former Commissioners and the practice of other countries, the Report advises that literature, mathematics, and science should be the accepted subjects of education up to the time at which boys leave school, and should all three be made compulsory in any School Leaving-Examination or University Matriculation; but that after entering the University students should be left to choose for themselves amongst these lines of study, and need pass no subsequent examination in subjects other than the one which they select. As regards the teaching of science, they recommend that it should commence with the beginning of the school career; that not less than six hours a week should be devoted to it, and that in all school examinations as much as one-sixth of the marks should be allotted to it.

These recommendations possess the two great excellences of authoritativeness and clearness. They are supported by a host of experienced witnesses, as well as by the eminent names whose signatures follow them. Their ideal of school education is simplicity itself. The supremacy of Classics is to be dethroned; the artifices of stratification and bifurcation are to be discarded; literature, mathematics, and science are to share a boy's intellect between them from the very first, until a leaving-examination which shows his progress to have been satisfactory in all three sets him free to follow his inclination by pursuing exclusively the subject which suits him best; happy since eminence in that one will not have been purchased by entire ignorance of all the others. Unfortunately, though most necessarily—for this Report concerns schools only—the curtain drops upon this interesting moment of transition, shutting out of view the influence which University Scholarships and Exhibitions exercise upon school work, and thus ignoring an obstacle to the realisation of the programme far greater than want of money, want of time, or want of appreciation, in the schools themselves.

What is the avowed object and purpose of the higher English school education? Is it the even and progressive development of young minds? the strengthening in equal proportion of the faculties of imagination, memory, reason, observation? the opening doors of knowledge in the plastic time of youth, which if not opened then will be fast closed in later years by the pressure of active work, or habitual exclusiveness, or energies paralysed through disuse? Nothing of the kind. It is constructed entirely with the aim of winning certain prizes; for scholarships with which a costly University bribes men to come to it for education; for class-lists leading up to College Fellowships; for the lucrative posts of military and civil service. In all these, but most of all where the Universities can determine the ordeal, one principle of success has been established, and that principle is one-sidedness. The candidate for India, for Woolwich, for Cooper's Hill, must at an early age select certain subjects and throw overboard all the rest. The childish aspirant to the entrance scholarships of a public school is placed in the hands of a crammer at eight years old, that at thirteen he may turn out Latin verses as a Buddhist prayer-mill turns out prayers, and may manifest, as a distinguished head-master has lately said, to the eye of a teacher searching for intelligence, thoughtfulness, promise, intenseness, "a stupidity which is absolutely appalling." His scholarship won, he is pledged to pursue a course whose benefits are tangible and its evil consequences remote. The Universities have stamped upon all the schools one deep certainty, that for a boy to be "all round," as it is called, is the irremissible sin; that a schoolmaster who teaches with reference to intellectual growth and width of culture sacrifices thereby all hope of the distinctions which make a school famous and increase its numbers. If a classical scholarship is desired, science and mathematics are abandoned: nay, the palm of literary excellence is conceded even to men ignorant of the noblest literature in the world, their own birthright and inheritance, and knowing less of the history and structure of the English language than a fourth form boy knows of Greek. If mathematical success is aimed at, literature and science are ignored; if the few science scholarships existing tempt candidates from any of "the thirteen schools which possess a laboratory," mathematics in part and literature altogether must be given up. It would be waste of words to point out the fatal tendency of this separative process; to show how mere linguistic training needs the rationalising aid of scientific study, or how exclusive science hardens and materialises without the refining society of literature; yet such divorce is inevitably due not to the convictions of schoolmasters, not to the influence of parents, not to the prepossessions of the public, but to the irresistible force of the University system, which makes narrowness of intelligence and imperfect knowledge the only avenues to distinction or to profit.

It is true that an attempt to alter this involves little short of a revolution; but by all accounts a revolution is at hand. It is not for nothing that a parliamentary investigation into the expenditure of college endowments should have been supported by members of the colleges themselves, or that a proposal to distribute college scholarships and exhibitions by a central authority in accordance with the results of the leaving-examination should have emanated from eminent university teachers. For it cannot be too strongly urged that college scholarships stand on very different ground from university prizes or degrees. It is easy for Parliament to lay down rules which shall control the latter once for all; it is not easy to bind the actions of some forty different foundations, each electing its own scholars according to its own idiosyncrasies, or in obedience to the changing wills of bodies in a perpetual state of flux. It may still be audacious, but it is no longer novel, to suggest that, supposing future legislation to retain the college scholarships at all, they should be awarded by the authority of Government, in strict connection with leaving-examinations which Government shall conduct, and in reward not of special but of general proficiency. For this the scheme of the Commissioners virtually contends; into regions beyond this the Report before us necessarily does not enter.

It will be seen that we accept, and recommend all teachers to accept, the scheme of the Commissioners unreservedly as a working basis of educational improvement. It may not be ideally perfect; it may invite opposition on points of detail; but it is the resultant of all the intellectual forces which have hitherto been brought to bear upon the subject; and while agreeing with all its witnesses on the principle that wide general training should precede specialisation of study, it attains extreme simplicity of arrangement by allotting the first of these to the Schools and the last to the Universities. Do not let us forget that the cry which has arisen hitherto from all the head-masters on the point of scientific teaching has been a cry for guidance; for commanding and intelligent leadership; for authoritative enlightenment as to the relative value and the judicious sequence of scientific subjects; for information as to text-books, apparatus, teachers. For the first time this cry is met by an oracle whose authority no one will question, and whose completeness of delivery all who study its utterances will appreciate. Schoolmasters anxious to teach science, and doubtful how to set about it, will meet all the facts which can enlighten them in the Appendices to the Report. They will find lists of accredited text-books, specimens of examination papers, varieties of school time-tables, priced catalogues of apparatus, syllabi of lectures and experiments, botanical schedules and tables, plans and descriptions of laboratories, workshops, museums, botanic gardens; programmes and reports of school scientific and natural history societies. They will learn how costly a temple could be built to Science at Rugby, and how modestly it could be housed at Taunton. They will see how Mr. Foster teaches physics, how Mr. Hale teaches geography, how Mr. Wilson teaches *Erdkunde*. And they will accept all this as coming from men who have a right to speak, and who wield an experience such as has not been amassed before. On any legislative change which impends over the system and the endowments of the higher English education, the body of scientific opinion is strong enough, if united, to impress its own convictions; disunion alone can paralyse it. All who feel the discredit of past neglect, its injury to our national intellect, and its danger to our national prosperity, will do well to support by unqualified adhesion the first attempt that has been made to probe its causes, and the first consistent and well-considered scheme that has been put forth for its removal.

W. TUCKWELL

DREW'S "JUMMOO AND KASHMIR"

The Jummoo and Kashmir Territories. A Geographical Account. By Frederick Drew, F.R.G.S., F.G.S., Associate of the Royal School of Mines. (London: Stanford, 1875.)

THE author of this work was for ten years, from 1862, in the service of the Maharaja of Kashmir, his primary duty apparently being the investigation of the mineral resources of the territory. During this period his duties led him to visit many parts of the Maharaja's dominions, and thus he had unusual opportunities of becoming well acquainted with the various districts and peoples under the sway of that ruler. Mr. Drew's previous training had qualified him to take intelligent advantage of his position and opportunities, and the result is the present bulky work, occupying 550 pages.

It is a perfect mine of information about the Kashmirian territories, more especially about their physical and political geography and their ethnology, while occasional details are introduced as to their zoology and botany. Mr. Drew delivers a "plain unvarnished tale," and has made no attempt to work his materials up into a merely popular book. Indeed, it might have been an advantage had he exercised a little more skill in arrangement; but with this defect we are not disposed to find serious fault, as every page of the work contains valuable information, which, by means of contents and index, is, after all, easily got at. Mr. Drew has made a substantial contribution to our knowledge of one of the most interesting regions of the globe.

Most Europeans, we suspect, have but a vague notion of how much is included under the name Kashmir. After all, Jummoo has a better title to give a name to the dominions of the Maharaja, as it is in the capital of this district that he resides. Jummoo is quite near the southern boundary of the Kashmirian territories, on a branch of the Chinab river, and hence must arise many inconveniences in the government of the country.

The territory included under the sway of the Maharaja is somewhat extensive, and of great variety in climate, physical characteristics, and races, extending from the broiling plains of the Panjab to the immense glaciers and eternal snows of the highest Himalayas, and including peoples both of Aryan and Turanian affinities, and of Mohammedan, Buddhist, and Brahman faiths. Looking down, however, upon the general map which accompanies Mr. Drew's volume, it is seen that the great mass of the territory is distinctly mountainous, and that to such an extent that one wonders where there can be any room for a population at all. Besides Jummoo and Kashmir, the countries of Ladakh, Baltistan, and Gilgit are included in the Maharaja's territories, whose entire area is estimated at 68,000 square miles.

Mr. Drew's plan is first in an introduction to present a general view of the Kashmirian territories, and then in succeeding chapters to treat of the various districts. The main characteristics of each district and its inhabitants are described in some detail, after which Mr. Drew takes the reader along a particular route which he himself has traversed, pointing out with great minuteness all that is worthy of note by the way. As Mr. Drew records mainly his own experiences, and as he is seldom tempted aside from the record of facts, it will be seen that the work is well adapted to afford the reader a clear and full idea of a region that is well worth becoming intimately acquainted with.

High Himalayan peaks east of Nubra.

Mr. Drew divides the entire territory from a physical point of view into three regions, commencing at the plain of the Panjab and proceeding northwards. These are, first, the region of the Outer Hills, composed of mountains averaging from 2,000 to 4,000 feet above sea-level; second, the Middle Mountains, averaging between 8,000 and 10,000 feet; and lastly, the region of the lofty Himalayas, the mountains in which vary in height from 15,000 to 27,000 feet. There are many points in Mr. Drew's descriptions into which we wish we could enter in some detail, many observations concerning the country and the people we should like to lay before our readers, but this is impossible; a mere enumeration of the contents of the work would occupy most of the space at our command.

Of the inhabitants especially of this curious region, so near the supposed cradle of the Aryan race, and where the Aryans and Turanians meet, and sometimes intermingle, Mr. Drew has much to say that will no doubt command the attention of ethnologists. He observed carefully and records faithfully the characteristics and ways of the varied peoples, and although these have been observed by previous travellers, still it will be found, we are sure, that Mr. Drew has made an important contribution to the ethnology of the region. The Aryan people of Kashmir he divides into five principal races: the Dogra, Chibali, Pahari, Kashmiri, and Dard; and the Turanian, which belong to the Tibetan section of that group, into Balti, Ladakhi, and Champa. As might be expected, Mr. Drew gives much information concerning the castes of the Aryan races, and what he tells us is full of interest. He throws some light also on the probable origin of castes, and especially of the distinction between the superior and inferior castes, and produces some very good reasons for believing that they are a result of the conquest of an inferior by a superior race. Mr. Drew was governor of Ladakh for a period, and thus had a splendid opportunity of becoming acquainted with an interesting region and curious people. He of course refers to the peculiar marital institution of the Turanians in the comparatively barren districts of the Himalayas. In Baltistan the people are of the same race as the Ladakhis, but having been converted to Mohammedanism, have eschewed polyandry for polygyny, with the result that the population has increased beyond the capacity of the country to support it, rendering emigration necessary.

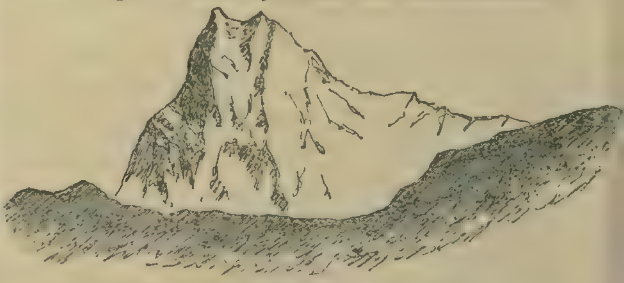
Mr. Drew presents minute studies of several places in Ladakh, especially of the salt lake district to the south of Leh. After carefully observing the geological characteristics of the district, he concludes that at one time, when glaciers were more universal than now, there must have been there one extensive and deep lake. Mr. Drew is constantly turning aside to make minute studies in geology and physical geography of this kind, and as the phenomenon investigated is generally of a typical sort, the scientific value of the book is thus much enhanced.

Of course Mr. Drew has a great deal to say about the Himalayas and their glaciers—glaciers on a scale, as he says, not to be met with elsewhere beyond the Arctic regions. Though Mr. Drew's style is unadorned, it has the merit of being always perfectly clear, so that his descriptions of glacial and other phenomena convey real and valuable information. One glacier he examined at Basha, in Baltistan, was upwards of twenty miles long, and others are to be met with of much greater extent; indeed, to judge from the map, this north-west Himalayan region is one huge net-work of glaciers. The largest of all is the Baltoro glacier, thirty-five miles long, which comes down between two lofty ridges; the northern ridge rises in one spot to the height of 28,265 feet, the peak of that height (K 2 of the Indian Survey) being the second highest mountain known in the world. And yet these glaciers are a mere remnant, the evidence seems to show, of the glacial covering which at one time spread over the Himalayan region.

One interesting excursion made by Mr. Drew was to the district in the N.E. of Ladakh, which, in the form of a great mountain-surrounded plateau, extends to the Kuenlun Mountains. This plain is divided into two by a low range of mountains running east and west, the southern half being known as the Lingzhithang Plain, and the northern half is named by Mr. Drew the Kuenlun Plain. This extensive and almost lifeless plateau has been crossed before Mr. Drew's journey, by various travellers—the unfortunate A. Schlagentweit, Mr. W. H. Johnson of the G. T. Survey, Mr. Haywood, Mr. Shaw, Dr. Cayley, and the two Yarkand Mission parties. Mr. Drew discusses the observations of some of these observers, and from observations made by himself, comes to the conclusion that the entire plateau must at one time have been under water, the mountains in the centre appearing above the surface as islands. His account of his observations on this journey are of considerable value as supplementary to those of previous observers—of the mirage, of the capricious lakelets which are still sometimes seen, of the composition of the surface of the plateau, of the remains of shingly beaches, salt deposits, and other features. This great plateau has by no means been yet fully explored, though it would be likely to yield to a competent observer important data in physical geography.

One special chapter is devoted to the various languages spoken in the territories, and their relationships well pointed out. In the appendices, also, material is provided for the comparative philologist in a Dogra grammar, various vocabularies and phrases.

A characteristic and valuable feature of the work is the series of maps which enable the reader to follow satisfactorily all the author's routes and descriptions. First of all there is a general map on the scale of sixteen miles to an inch, sufficiently minute to enable one to recognise the chief physical features, and in which the various glaciers are indicated. Then come five maps, constructed each from a different and special point of view. The "Snow Map" is coloured, to show the characteristics of various regions of the territory in respect of snow, from the region of "no snow" to that of glaciers. The "Race Map" shows the distribution of the various peoples which make up the population of the country, while the "Language Map" and the "Faith Map" serve the same purpose for languages and religions respectively. The "Political Map" shows the various previously independent states and rajaships which have been gradually agglomerated into one dominion under the Maharaja of Jummoo. Besides the maps there are isometric views and sections of the principal mountain regions, and a number of illustrations of places and people. We think the illustrations, especially in the way of typical photographic portraits, ought to have been more abundant in a work otherwise so elaborate and minute; but this may be remedied in a second edition.



K 2 of Indian Survey, 28,265 feet, as seen from Turmik.

We have given but a faint idea of the contents of this thick volume, but perhaps we have said enough to show that henceforth it must be considered as one of the principal authorities on a country of great interest in itself, and of special interest to English people on account of its relation to our Indian dominions and government. Much has already been written on the country and on the regions which border upon it, and special studies have been made of particular parts and aspects of it—Mr. Drew refers with deserved praise to Dr. Leitner's great work on Dardistan;—but on the country as a whole, in all its aspects, political, historical, ethnological, and physical, Mr. Drew's work must be considered as a permanent and trustworthy authority.

OUR BOOK SHELF

Zoology for Students. By C. Carter Blake, D.Sc. (Daldy, Isbister, and Co., 1875.)

IN this work Dr. C. C. Blake has published, as he tells us in the preface, the substance of his annual course of lectures on zoology at Westminster Hospital. Beginning with the highest form, man, he descends the whole scale of animal life, ending with the Protozoa, or Acrita. A general description of each class is followed by a more detailed account of each of the different orders which compose it. As a preface, "notes" taken from some of Prof. Owen's Hunterian Lectures on the principles of zoological classification, are, with the lecturer's permission, introduced.

The arrangement adopted is not the most modern. The Batrachina and the other Amphibia are retained as orders of the class Reptilia; the importance of the different sections of the Teleostei is considered to be as great as that of the Ganoidei or Plagiostomi; the Cirripedia are separated from the Crustacea; the "Bryozoa" are associated with the "Radiata," and the Entozoa are retained among the Articulata. More stress is laid on external peculiarities than is the custom now-a-days, among biologists, and the importance of embryology is not made prominent. Theoretical considerations are placed in the background, and illustrations are but few and far between. The fossil orders are described in their respective classes, and some of Prof. Owen's tables of the distribution in time of their different genera are introduced.

There is, no doubt, some advantage to a student with time at his disposal commencing the science upon an antiquated classification, for it enables him afterwards to more fully comprehend the history of biology, and to appreciate the rapid strides that have been made. We, however, fear that it is the object of most who take up the subject to obtain, as quickly as possible, a clear idea of its present position; and such being the case, to commence with a bygone system is only so much loss of time. The view taken by Dr. Blake will therefore detract from the value of his otherwise useful work. Another thing that will diminish its value is a certain want of accuracy which pervades it. Drawings of the feet of three birds are given, and they are all wrongly named. A scansorial foot is adjudged to a passerine bird; that of a kingfisher is said to be gallinaceous, whilst that of a steganopod is termed "foot of duck." More than once the peculiarities of two closely allied animals are reversed, as when we are told that among the Proboscidia "in one form, entirely extinct (Dinotherium), the incisors project in the form of long tusks from the upper jaw; in the existing elephants, from the lower jaw," and when "the articulated group (of the Brachiopoda are said to) possess an anal aperture, the non-articulated possess none whatever."

The chapter on the Pisces is much confused. "The living Ganoids have completely bony skeletons, but the fossil ones may have had skeletons soft and cartilaginous like those of the Sturgeons. . . . They have several holes in the arterial trunks. . . . Their optic nerves do not decussate, but merely cohere laterally." The external nares are said to be "simple" in the Rays and Sharks, or "double, as in most osseous fishes." The Ammocete is called the Sandlaunce, and it is described as a separate genus.

The same character is more than once repeated on the same or the following page, whilst others equally important are omitted. On the first page of the section describing the Reptilia, the two following sentences occur as parts of the definition of the class: "a heart with two auricles, and with the ventricle more or less completely divided;" "the heart has two auricles; the ventricle is imperfectly divided." Pentastoma is retained among the "Entozoa," instead of being placed among the Arachnida; we can find no reference to Ceratodus, a most important fish theoretically; and the brain of the Marsupials is said not to possess a corpus callosum.

Notwithstanding the imperfections above pointed out, there is much to be learnt from Dr. Blake's work; many of the descriptions are excellent; nevertheless there are so many essential facts omitted, that it will be found more valuable as an adjunct to a work like Prof. Huxley's "Introduction to the Classification of Animals," than as an independent source of information.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

"Instinct and Acquisition"

IN NATURE (vol. xii. p. 507) there appears, under the above heading, a very interesting article, being an epitome of a paper read by Mr. Spalding at the Bristol meeting of the British Association. Now that the doctrine which is maintained in this article—a doctrine with which Mr. Spalding's name is associated as almost its only experimental verifier—has proved itself so completely victorious in overcoming the counter-doctrine of "the individual-experience psychology"—and this along the whole line both of fact and theory—it seems unnecessary for anyone to adduce additional facts in confirmation of the views which Mr. Spalding advocates. I shall therefore confine myself to detailing a few results yielded by experiments which were designed to illustrate the subordinate doctrine thus alluded to in Mr. Spalding's article:—

"Though the instincts of animals appear and disappear in such seasonable correspondence with their own wants and the wants of their offspring as to be a standing subject of wonder, they have by no means the fixed and unalterable character by which some would distinguish them from the higher faculties of the human race. They vary in the individuals as does their physical structure. Animals can learn what they did not know by instinct and forget the instinctive knowledge which they never learned, while their instincts will often accommodate themselves to considerable changes in the order of external events. Everybody knows it to be a common practice to hatch ducks' eggs under a common hen, though in such cases the hen has to sit a week longer than on her own eggs. I tried an experiment to ascertain how far the time of sitting could be interfered with in the opposite direction. Two hens became broody on the same day, and I set them on dummies. On the third day I put two chicks a day old to one of the hens. She pecked at them once or twice, seemed rather fidgety, then took to them, called them to her, and entered on all the cares of a mother. The other hen was similarly tried, but with a very different result. She pecked at the chickens viciously, and both that day and the next stubbornly refused to have anything to do with them," &c.

It would have been well if Mr. Spalding had stated whether these two hens belonged to the same breed; for, as is of course well known, different breeds exhibit great variations in the character of the incubatory instinct. Here, for instance, is a curious case. Spanish hens, as is notorious, scarcely ever sit at all; but I have one purely-bred one just now that sat on dummies for three days, after which time her patience became exhausted. However, she seemed to think that the self-sacrifice she had undergone during these three days merited some reward, for, on leaving the nest, she turned foster-mother to all the Spanish chickens in the yard. These were sixteen in number, and of all ages, from that at which their own mothers had just left them up to full-grown chickens. It is remarkable, too, that although there were Brahma and Hamburg chickens in the same yard, the Spanish hen only adopted those that were of her own breed. It is now four weeks since this adoption took place, but the mother as yet shows no signs of wishing to cast off her heterogeneous brood, notwithstanding some of her adopted chickens have grown nearly as large as herself.

The following, however, is a better example of what may be called plasticity of instinct. Three years ago I gave a pea-fowl's egg to a Brahma hen to hatch. The hen was an old one, and had previously reared many broods of ordinary chickens with unusual success even for one of her breed. In order to hatch the pea-chick she had to sit one week longer than is requisite to hatch an ordinary chick, but in this there is nothing very unusual, for, as Mr. Spalding observes, the same thing happens with every hen that hatches out a brood of ducklings.* The object with which I made this experiment, however, was that of ascertaining whether the period of maternal care subsequent to incubation admits, under peculiar conditions, of being prolonged; for a pea-chick requires such care for a very much longer time than does an ordinary chick. As the separation between a hen and her chickens always appears to be due to the former driving away the latter when they are old enough to shift for themselves, I scarcely expected the hen in this case to prolong her period of maternal care, and indeed only tried the experiment because I thought that if she did so the fact would be the best one imaginable to show in what a high degree hereditary instinct may be modified by peculiar individual experiences. The result was very surprising. For the enormous period of eighteen months this old Brahma hen remained with her ever-growing chicken, and throughout the whole of that time she continued to pay it unremitting attention. She never laid any eggs during this lengthened period of maternal supervision, and if at any time she became accidentally separated from her charge, the distress of both mother and chicken was very great. Eventually the separation seemed to take place on the side of the pea-cock; but it is remarkable that although the mother and chicken eventually separated, they never afterwards forgot each other, as usually appears to be the case with hens and their chickens. So long as they remained together the abnormal degree of pride which the mother showed in her wonderful chicken was most ludicrous; but I have no space to enter into details. It may be stated, however, that both before and after the separation the mother was in the habit of frequently combing out the top-knot of her son—she standing on a seat, or other eminence of suitable height, and he bending his head forwards with evident satisfaction. This fact is particularly noteworthy, because the practice of combing out the top-knot of their chickens is customary among pea-hens. In conclusion I may observe, that the pea-cock reared by this Brahma hen turned out a finer bird in every way than did any of his brothers of the same brood which were reared by their own mother, but that on repeating the experiment next year with another Brahma hen and several pea-chickens, the result was different, for the hen deserted her family at the time when it is natural for ordinary hens to do so, and in consequence all the pea-chickens miserably perished.

I have just concluded another experiment which is well worth recording. A bitch ferret strangled herself by trying to squeeze through too narrow an opening. She left a very young family of three orphans. These I gave, in the middle of the day, to a Brahma hen which had been sitting on dummies for about a month. She took to them almost immediately, and remained with them for rather more than a fortnight, at the end of which time I had to cause a separation, in consequence of the hen having suffocated one of the ferrets by standing on its neck. *During the whole of the time that the ferrets were left with the hen the latter had to sit upon the nest*; for the young ferrets, of course, were not able to follow the hen about as chickens would have done. The hen, as might be expected, was very much puzzled at the lethargy of her offspring. Two or three times a day she used to fly off the nest, calling upon her brood to follow; but upon hearing their cries of distress from cold, she always returned immediately and sat with patience for six or seven hours more. I should have said that it only took the hen one day to learn the meaning of these cries of distress; for after the first day she would always run in an agitated manner to any place where I concealed the ferrets, provided that this place was not too far away from the nest to prevent her from hearing the cries of distress. Yet I do not think it would be possible to conceive of a greater contrast than that between the shrill peeping note of a young chicken and the hoarse growling noise of a young ferret. On the other hand, I cannot say that the young ferrets ever seemed to learn the meanings of the hen's clucking. During the whole of the time that the hen was allowed to sit upon the ferrets she used to comb out their hair with her bill, in the same way as hens in general comb out the feathers of their chickens. While engaged in this process, however, she used frequently to stop and look with one eye at the wriggling nest-full with an inquiring gaze expressive of astonishment. At other times, also, her family gave her good reason to be surprised; for she used often to fly off the nest suddenly with a loud scream—an action which was doubtless due to the unaccustomed sensation of being nipped by the young ferrets in their search for the teats. It is further worth while to remark that the hen showed so much uneasiness of mind when the ferrets were taken from her to be fed, that at one time I thought she was going to desert them altogether. After this, therefore, the ferrets were always fed in the nest, and with this arrangement the hen was perfectly satisfied—apparently because she thought that she then had some share in the feeding process. At any rate she used to cluck when she saw the milk coming, and surveyed the feeding with evident satisfaction.

Altogether I consider this a very remarkable instance of the plasticity of instinct. The hen, it should be said, was a young one, and had never reared a brood of chickens. A few months before she reared the young ferrets she had been attacked and nearly killed by an old ferret which had escaped from his hutch. The young ferrets were taken from her several days before their eyes were open.

In conclusion I may add, that a few weeks before trying this experiment with the hen I tried a similar one with a rabbit. In this case the ferret was newly born, and I gave it to a white doe rabbit which had littered six days before. Unlike the hen, however, she perceived the imposture at once, and attacked the young ferret so savagely that she broke two of its legs before I could remove it. To have made this experiment parallel with the other, however, the two mothers ought to have littered on the same day. In this case the result would probably have been different; for I have heard that under such circumstances even such an intelligent animal as a bitch may be deceived into rearing a cat, and *vice versâ*.* GEORGE J. ROMANES

Dunskaith, Ross-shire, Oct. 10

Curious Australian and N. American Implement

A VERY interesting illustration of the occurrence of the same specialised implement in widely separated regions is found in the resemblance between the vermin hooks of the Australians and the same kind of weapon found among the Ute Indians. Several of the former were brought home by Wilkes' Expedition, and are found in the National Museum (Fig. 1). They have highly finished handles, and the bone hook is fastened on with wrapping and gum. Of the latter, Major Powell, in his Colorado Report (1875), says, "These Indians all carry canes with a crooked handle, they say to kill rattlesnakes, and to pull rabbits from their holes" (Fig. 2).

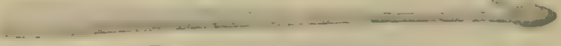


FIG. 1.—Australian vermin hook.

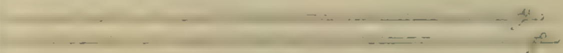


FIG. 2.—Pai-Ute vermin hooks.

The Ute implement is very rude, consisting of a switch merely, with the bark stripped off, and a nail passed through the thick end at an acute angle, and firmly lashed with sinew. Major Powell's Fig. 45, entitled "The Human Pickle," has two of these hooks (or canes) in his hand. O. T. MASON.

Washington, D.C., Oct. 13

OUR ASTRONOMICAL COLUMN

DOUBLE STARS. (1) *p* ERIDANI.—In the year 1850 the late Capt. Jacob calculated two orbits for this binary system, the second of which represents very fairly his subsequent measures to the end of 1857, a rather severe test for elements founded upon the data available in 1850. We look in vain for measures later than Capt. Jacob's, though it may be hoped this and other interesting objects of the southern heavens have not been entirely neglected of late years. The public observatories are perhaps too closely occupied with other work to allow of much being expected from them in a class of observation peculiarly suited to the amateur astronomer, but there must be a grand field of operations for private observers, in southern double and variable-star astronomy.

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* The greatest prolongation of the incubatory period I have ever known to occur was in the case of a pea hen which sat very steadily on addled eggs for a period of four months, and had then to be forced off in order to save her life.

* *Apropos* to what Mr. Spalding says about the early age at which the instinctive antipathy of the cat to the dog becomes apparent, I may state that some months ago I tried an experiment with rabbits and ferrets somewhat similar to that which he describes with cats and dogs. Into an outhouse which contained a doe rabbit with a very young family I turned a ferret loose. The doe rabbit left her young ones, and the latter, as soon as they smelled the ferret, began to crawl about in so energetic a manner as to leave no doubt that the cause of the commotion was fear, and not merely the discomfort arising from the temporary absence of the mother.

Capt. Jacob's last orbit of *p* Eridani may be written thus :—

Peri-astron passage	1819·83
Node	110° 40′
Node to peri-astron in direction of motion ...	285° 50′
Inclination	46° 36′
Excentricity	0·323
Semi-axis	4″·25

Mean annual motion, −3°·3645, or period of revolution 107 years.

The components are of equal brightness, and hence it is to be expected some measures may be registered 180° different from others; accordingly, to work the whole series into any supposable orbit it is necessary to add 180° to Sir J. Herschel's micrometrical measures (Cape Obs., p. 276), and indeed it will be seen that he has so recorded the angles of the 20-feet sweeps, p. 174.

The errors of the above orbit are, for

1835·00	Pos. (*c* − *o*)	+ 2°·5	Dist. (*c* − *o*)	0″·00
1857·96	,,	− 1°·6	,,	+ 0″·03

The following are deduced from the same orbit :—

1875·0	Pos.	218°·9	Dist.	3″·92
76·0	,, ...	216°·3	,, ...	3″·89
77·0	,, ...	213°·7	,, ...	3″·86

As the measures of this star are, so far, scattered in several volumes, they are collected here for convenience of reference. Dunlop's angle was evidently registered in the wrong quadrant, as is pointed out both by Sir J. Herschel and Capt. Jacob; the correct reading appears to be 343° 6′.

			°		″
Dunlop	1825·96	Pos.	343·1	Dist.	2·5
Herschel	35·00	,,	302·3	,,	3·65
Jacob	45·88	,,	276·0	,,	4·16
,,	46·83	,,	277·0	,,	4·32
,,	49·82	,,	270·0	,,	—
,,	50·80	,,	268·73	,,	4·32
,,	51·79	,,	266·38	,,	4·30
,,	52·76	,,	264·84	,,	4·14
,,	53·99	,,	263·24	,,	4·36
,,	56·09	,,	261·12	,,	4·70
,,	57·96	,,	258·18	,,	4·49

The place of *p* Eridani for the commencement of 1876 is in R.A. 1h. 35m. 5s., and N.P.D. 146° 49′·5.

(2) O. Σ 387.—Between the epoch of Mr. Otto Struve's measures in 1844 and Baron Dembowski's in 1868, the angle in this binary has retrograded 77°, and no doubt if measures are obtained this year a very considerable further change will be manifested: yet the distance, if we except Secchi's estimate in 1856, has been found about half a second, as long as the star has been under observation. A first approximation to the elements may soon be practicable. The place of this object for beginning of 1876 is R.A. 19h. 44m. 6s., and N.P.D. 55° 0′·1. The number applies to the Pulkova Catalogue of 1850.

THE MINOR PLANETS.—No. 150 of the group of small planets has been reached, Prof. Watson, director of the Observatory of Ann Arbor, Michigan, having detected another member, apparently on the night of October 18; the place as yet doubtful, the telegrams through the French and English cables being discordant. It is stated to be of the 10th magnitude, and is therefore brighter than the great majority of planets discovered during the last few years. Considering the close scrutiny which the ecliptical region of the sky is receiving at the present day, we must surely soon be in a position to pronounce with some degree of confidence whether any trans-Neptunian planet as bright as stars of the 13th magnitude exists within 2½° or 3° from the ecliptic, and in the event of greater inclination, the scheme of Prof. Peters, on its completion, may afford an equally definitive conclusion. There have been some curious alarms in this direction, as in the autumn of 1850, during observations of the minor planet Hygeia at Washington, when an apparently slow moving object was compared with the planet on more than one evening; but although sought for diligently on the supposition of its being a distant body, was not recovered, nor, we believe, has since been seen in the observed place. The change of position was larger than could well be attributed to casual errors in micrometric observations; but there seems to be no other explanation of this case, except admitting error of observation and the existence of a variable star of long period in that spot.

NOTES FROM THE "CHALLENGER"

PROF. WYVILLE THOMSON has just sent me from the *Challenger* an account of certain results of Deep Sea dredgings in the North Pacific. In these dredgings was obtained a Gymnoblastic Hydroid of such colossal dimensions that the largest form hitherto known sinks in comparison with it into utter insignificance. Prof. Thomson has determined the Hydroid as a MONOCAULUS or nearly allied form, and a beautiful drawing which accompanies his letter confirms this view.

The animal itself has not yet arrived, but the letter which gives an account of its capture contains so many points of general interest, that the following extract will, I feel sure, be acceptable to the readers of NATURE :—

"H.M.S. *Challenger*, N. Pacific, July 24, 1875.

. . . .

"On the 17th of June, in the North Pacific, lat. 34° 37′ N., long. 140° 32′ E., depth 1,875 fathoms, temperature at bottom 1° 7 C., bottom grey mud, the trawl brought up three or four examples of what seems to be a species of MONOCAULUS, or something allied to it. The point which naturally struck us most was that the hydranth in a specimen measured fresh by Moseley and myself, was nine inches across from tip to tip of the expanded (non-retractile) tentacles, and the hydrocaulus was seven feet four inches high! On the 5th of July, lat. 37° 41′ N., long. 177° 4′ W., depth 2,900 fathoms, with bottom temperature the same as before, and a bottom of red clay with manganese nodules, the trawl, which was torn to pieces by having taken in too great a weight of nodules of manganese, brought up entangled in its outer netting another fine specimen of this same form. It was put in weak picric acid, and then into weak alcohol, and you have it in the short piece of test-tube among the horsehair. This specimen was not measured, but the hydranth was carefully sketched by Mr. Wild, and I enclose you the sketch.

"These delicate things, drawn up rapidly through the water from a depth of nearly four statute miles, and transported into such totally different conditions of temperature, pressure, &c., suffer greatly from the violent change: they are in fact almost knocked to pieces, and their finer tissues are in a nearly deliquescent state, so that our great anxiety is to get them at once into some reagent which will harden them somewhat. It is wretched to see them melting away absolutely under one's eyes: when put into any of our fluids they at once contract out of all form, but that cannot be helped. I thought it best you should have them as well preserved as we could manage, so I only gave them a cursory glance and sent them on.

"The hydrocaulus is enormously extensile—it is of a pale pink colour, and our specimens, when distended in the water, were about four feet or so long: one, as I mentioned before, which Moseley and I measured, was seven feet four inches high, but that one was stretched over the surface of the trawl net, and although it must of course have been capable in life of extending to that degree, it might not have been a normal attitude. When at what seems to be its normal state of distension, the diameter of the hydrocaulus is about half an inch. Its structure you can make out for yourself. The proximal ends of several of them were coated with mud when they came up; the longitudinal striæ were very evident in the soft tissue; fluid gravitated down the centre of the hydrocaulus, and collected in a bladder-like expansion at the base. The base of this stem was of a darker colour than the rest—a dull rose—in most of them (not in the one figured by Wild). As I did not mean to describe the creature I did not look out for processes or fibrillæ at the proximal extremity; you may find them in the spirit specimens. The total length of the hydranth when moderately extended was 1½ inches.

"The proximal range of tentacles number about a hundred, and these are about four inches long—they are almost transparent in life—of a pale pink colour in most specimens. The sporosacs are in close tufts of a maroon colour just at the base of the proximal tentacles. The specimen I looked at was a male, but the tissues were so soft—almost slimy—that I did not like to tease it too much. The walls of the body-cavity were yellowish, and seemed to contain some vertical rolls of glandular matter, and the hypostome terminates in a fringe of about forty-eight or fifty extensile tentacles round the mouth. So much for our gigantic Corymorphoid! These are the only two occasions on which we got it, or anything like it. I should have liked to get a haul or two in Behring's Sea, for there doubtless we should have had it in shallow water. I can only tell you one thing more about it—its associates. On the 17th of June, 1875, in 1,875 fathoms, it was associated with many fishes (Ophidoids, Macrurids, Scopellids—all the usual deep-sea lot), several Gasteropods, many Crustaceans (Dorippe, Galatea, Caridids, &c., and a fine Scalpellum), a few Annelids, many Echinoderms (Brisinga, Phormosoma, Ophiurids, two very fine Holothurids of a new group), species of Isis, Primnoa, Polythoa, and Actinia. On the 5th of July, in 2,900 fathoms, there were some worms (Aphroditacean), an Urchin allied to Diadema, two Holothuriæ, and one or two sponges; but the trawl-net was torn by the weight of the manganese nodules, so we had scarcely a fair sample of the fauna. In the bottle with the tube you will find among the horsehair one or two pieces of *Heliopora cerulea* from Moseley. He sends at the same time a paper on it to the Royal."

That the enormous depths from which this colossal Hydroid has been brought up should favour the development of gigantic representatives of the diminutive forms of shallower zones, and that in the tenants of these sunless regions of the sea we should find colour not less vivid than that of their light-loving relatives, are facts full of significance.

It is also worth noticing that the sexual zooids of the great Hydroid are to all appearance simple sporosacs, instead of the medusiform zooids which are so frequent in the Gymnoblastic Hydroids of our littoral regions. Indeed, among the many Hydroids which I have examined from deep water, I have never found one which could be referred with probability to a form characterised by the production of medusiform zooids. It would seem that these zooids—delicate and active organisms which are among the most abundant captives of the towing-net in the surface-zone of the sea—are unable to endure, either before liberation from their parent Hydroid, or for a period however short in their free state, the darkness and pressure and other conditions to which the dwellers in the deep sea are exposed. GEORGE J. ALLMAN

NORDENSKJÖLD'S ARCTIC EXPEDITION

A LETTER from Prof. Nordenskjöld to Mr. Oscar Dickson, of Gothenburg, appears in the *Goteborgs Handels Tidning* of the 14th inst. It is dated "On board the *Pröven*, at anchor at the mouth of the Jenesej, 16th August, 1875." The following extracts may be of interest to our readers:—

"We are now employed as busily as possible in equipping the boat in which I, accompanied by Dr. Stuxberg, docent Lundström and three men, intend to sail up the Jenesej, with the view of returning to Europe across Siberia, while the other part of the expedition returns to Norway by sea, on board the *Pröven*.

"After the *Pröven*, on the 8th of June, was towed free of cost out of Tromsö by a little steamer of the same name, we were compelled to lie at anchor in the sound between Carlsö and Renö for five days, on account of a head wind. Finally, on the 14th, we could again weigh anchor and get to sea through Fuglö Sound. We thereupon set our course past North Cape, which we passed on the 17th, to the southern part of Novaya Zemlya.

"During spring and the early part of summer the west coast of this double island is, for some distance from the land, surrounded by a compact ice girdle, impassable at most places, which disappears later in the season, and in which, according to the experience of the fishermen, there are formed, generally at an early period, two sounds which are covered only with thin passable drift-ice, and by which the ice-free belt of water along the coast is connected with the ice-free ocean westwards. One of these open channels is usually situated off Matotschkin Scharr, and its formation is caused by the strong currents which prevail in that sound; the other is to be found about the latitude of Severo Gusinnoi Mys, or North Goose Cape. The latter was chosen by me for the *Pröven*, and was passed without any special difficulty on the 22nd of June. The expedition thus, in seven days from its departure from Carlsö, cast anchor for the first time at Novaya Zemlya, in a little ill-protected bay immediately north of North Goose Cape.

"During the voyage there were set on foot, when the state of the weather permitted, frequent soundings and dredgings, examinations of animal and diatom life in the surface of the sea, determinations of the temperature at different depths, &c. Our operations were generally very successful, and showed that in this sea we may reckon on reaping rich harvests in natural history. We also made repeated trials at different depths of a new instrument for bringing up specimens of the bottom, constructed for the expedition by Dr. Wiberg, which showed itself very well adapted for the purpose, and easily managed."

After visiting and examining various parts of the coast for many days, the *Pröven* was directed to the Sea of Kara, and on the 26th July the anchor was let go off Cape Grebeni, on Waigats Island. So violent a storm was raging, however, that a boat could not be sent out till the 30th July to land on Waigats Island. "A rich collection was here made of Upper Silurian fossils, strongly resembling those from Gotland, and therefore of special interest for Swedish geologists. Here we for the first time encountered Samoyedes, who when they sighted the vessel drove down to the shore in peculiar high sledges adapted for travelling in both summer and winter, and drawn by three or four reindeer. They immediately gave us to understand that they wished to come on board, whither they also accompanied us in our boat, and where they were soon afterwards well entertained by us.

"During our stay on the west coast of Novaya Zemlya we of course instituted numerous investigations regarding the geology, animal and vegetable life, &c., of the regions visited by us, and the number of the places on the coast where we landed rendered it possible for the scientific staff of the expedition to collect materials for ascertaining the natural relations of these regions, which are certainly far more extensive than have been brought home by any of our predecessors." At last on August 2 the sound was successfully passed, and on the *Pröven* reaching the Sea of Kara it was found completely free of ice! "Our course was set towards the middle of the peninsula which separates the Sea of Kara from the Bay of Obi, and is named Jalmal by the Samoyedes. The wind was very moderate, so that we only advanced slowly—a circumstance by which our patience was in truth sorely tried, but which had this good result, that during our sailing forward in these waters visited for the first time by a scientific expedition, we were able daily to undertake dredgings, hydrographic work, &c. The dredgings gave an unexpectedly rich and various harvest of marine animals, among which I will specially mention here several colossal species of Isopoda, masses of Amphipoda and Copepoda, a large and beautiful Alecto, uncommonly large Ophiurids, beautifully marked Asterids, innumerable mollusca, &c. The peculiar circumstance here occurs that the water at the surface of the sea, which in consequence of the great rivers which debouch in these regions is nearly free of salt, forms a deadly poison for the animals which live in the salt water at the bottom. Most of the animals brought up from the bottom accordingly die if they are placed in water from the surface of the sea.

"Here, as on the west coast of Novaya Zemlya, were instituted, when opportunity offered, with the thermometers by Negretti and Zambra and Casella procured by you during your stay in London last spring, determinations of the temperature of the sea, not only at the surface, but also at different depths under it. These investigations yielded a specially interesting result, and perhaps may be regarded as conclusive of a number of questions regarding which there has of late been much discussion concerning the ocean currents in these regions, the direction of which, in the absence of other data, it has been attempted to determine chiefly by the temperature of the surface water. By means of numerous observations along the west coast of Novaya Zemlya from Matotschkin Scharr to Jugor Sound, and thence past Cape Grebeni to 75½° N. lat. and 82° E. long., and on to the mouth of Jenisej, I have obtained indisputable proof that in this sea the temperature of the sea-water at the surface is exceedingly variable and dependent upon the temperature of the air, upon the neighbourhood of ice, and upon the influx of warm fresh water from Obi and Jenesej, but that the temperature of the water at a depth of only ten fathoms is nearly quite constant, between $-1°$ and $2°$ C. If, in the northern part of the Sea of Kara, where the water on the surface is almost completely *free of salt*, and at this time of the year very warm, a flask filled with water from the surface is sunk to a depth of ten fathoms, the water freezes to ice. There are thus no warm ocean currents here at any considerable depth below the surface. A large number of deep-water samples have been taken by the apparatus constructed by Prof. Ekman, which is exceedingly well adapted for the purpose, and I am convinced that at the bottom the content of salt is also constant, which can be ascertained with certainty after the return of the expedition by analyses of the samples of water which have been taken.

"On the 8th August we landed for a few hours on the north-western side of Jalmal, where an astronomical determination of the position of the place was made. A great many astronomical determinations had previously been made during the expedition along the west coast of Novaya Zemlya and Jugor Sound. Traces of men, some of whom had gone barefoot, and of Samoyede sledges, were visible on the beach. Close to the shore was found a sacrificial altar, consisting of about fifty skulls of the Ice Bear, Walrus, and Reindeer bones, &c., laid in a heap. In the middle of the heap of bones there stood, raised up, two idols, roughly hewn from drift-wood roots, newly besmeared in the eyes and mouth with blood, also two poles provided with hooks, from which hung bones of the Reindeer and Bear. Close by was a fireplace and a heap of Reindeer bones, the latter clearly a remnant of a sacrificial meal. After a stay here of several hours, I sailed further north, until further advance in this direction was prevented by impassable masses of great even icefields at 75° 30′ N. lat., and 79° 30′ E. long. Afterwards I followed the edge of the ice eastwards, and finally steered our course towards the north side of the mouth of Jenisej, where the Swedish flag was hoisted and the anchor was let go on the 15th in the afternoon. We had now attained the goal which great seafaring nations had in vain striven for centuries to reach.

"The expedition will now, in accordance with the plan agreed upon, separate, inasmuch as I, accompanied by Lundström and Stuxberg, and three men, intend, in a Nordland boat brought with us for the special purpose, to sail or row up the Jenisej, in order to return by Turuchansk and Jeneseisk to Europe, while the *Pröven* returns hence to Norway, if possible going north of the north point of Novaya Zemlya."

SCIENCE IN GERMANY

(*From a German Correspondent.*)

SINCE we possess in the kinetic molecular theory, as founded by Clausius, a mechanical theory based on the atomic conception of gases, it is possible to employ the results of the chemical investigation of these bodies for physical deductions. It is only necessary to suppose for this purpose that *the same* molecules, which are the bearers of the thermal and mechanical properties of gases, act reciprocally in chemical reactions. We must point out as one of the most important confirmations of this view, that Avogardo's hypothesis, based on general physical deductions, and adopted in chemistry as the foundation-stone of its whole recent development, has lately found its mechanical confirmation in the gaseous theory of Maxwell and of Boltzmann.

Recently, however, difficulties have arisen in the further investigation of this theory, with regard to the specific heat of gases. The quantity of heat contained in a gas is defined as the total energy of its molecules, and this energy consists solely in progressive motion, if the molecule is looked upon as a mere material point. On the other hand, the pressure of the gas upon the surface-unit equals two-thirds of the kinetic energy of progressive motion contained in the volume-unit. If, therefore, we raise the temperature of the gas by one degree, the volume remaining the same, we can find by calculation the adduced quantity of heat according to the gaseous theory, from the increase of pressure determined by Mariotte-Gay Lussac's law. This quantity of heat in its relation to the mass-unit, is, as is known, called the specific heat of the gas at the constant volume (c), and calculation now shows this value to be 0·60 of the observed one. In close connection with this it was found that the proportion of specific heat at constant pressure (c') to the specific heat at constant volume (c), viz. $\frac{c'}{c} = k$ is $= 1{\cdot}67$ according to the theory mentioned, but $= 1{\cdot}405$ according to observation.

Clausius has shown that the theoretical value of c is certainly increased, if we take into account that according to the results of chemical researches the molecules of the gases hydrogen, oxygen, and nitrogen are *not* material points, but polyatomic, and that they are thus capable of storing, as it were, a certain quantity of energy in the shape of motion relative to a centre of gravity. But when Boltzmann lately investigated the behaviour of polyatomic gas molecules according to mechanical principles, he found c for a diatomic gas (like hydrogen, oxygen, nitrogen) to be 1·22 times more than observation shows. He found by calculation $k = 1{\cdot}33$, and this value is *smaller* than the actual one (1·405). We must remark here that the supposition of a number of atoms larger than

2 would decrease k still further, and here exists for the present an unsolved contradiction between experience and the theory in its present form.

Looking at this state of things, Herren Kundt and Warburg at Strasburg thought it advisable to investigate experimentally the simplest case which nature offers to us, viz. the case of a gas which, according to its chemical behaviour, is a monatomic one. Herr Baeyer pointed out to them that mercury gas was such a gas; they therefore undertook to determine the specific heat of mercury gas. Here a contradiction to the theory did *not* become apparent; the experiment has yielded exactly the value demanded by theory for a monatomic gas, viz., $K = 1{\cdot}67$. Thus it is proved that the molecule of mercury gas, with regard to its thermal and mechanical properties, behaves exactly like a material point. It is hardly necessary to remark that, with regard to other properties, it is not at all necessary that the same molecule should behave like a material point. Thus, for instance, one glance at the spectrum emitted by incandescent mercury gas, which is crossed by many bright lines, shows us at once that the molecule of the same, with regard to the light it emits, does certainly not behave like a material point.

With regard to the way in which the experiment was conducted, we confine ourselves to the following remarks.

The k for mercury gas was determined from the velocity of sound in this gas, and this was found by means of the method of dust figures, formerly described by Herr Kundt.* A glass tube A, closed at both ends, well dried and pumped perfectly free from air, contained a certain quantity of mercury, which had been carefully weighed, and a little silicic acid. Sealed to this tube was another one, B (this a little narrower), in such a manner as to form the prolongation of A. A was placed in a four-fold box made of iron plates, which was heated by a series of Bunsen burners. This box also contained the great reservoir of an air thermometer, and, if observations were made at a temperature under 354°, several mercury thermometers besides. The end of B, projecting from the box, was sealed up, and over this end a long wide glass tube D was placed, which was closed at one end and contained a little lycopodium.

If now, after the necessary regulation in the heating arrangements, the thermometers in the box showed equal and sufficiently elevated temperatures, the tube composed of A and B was sounded by friction to its third longitudinal tone; at the same time a reading of the air thermometer was taken, and the temperature of the air in D was noted down. The powders introduced then showed in tubes A and D the sound-waves in mercury gas and in air respectively, so that afterwards the lengths of these waves could be measured with the greatest accuracy.

Let us suppose

l to be the length of the sound-wave in air,
l' „ „ „ in mercury-gas,
t the absolute temperature of air in D,
t' „ „ of mercury gas in A,
$d = 6{\cdot}9783$ the density of mercury gas (air $= 1$),
k – the proportion $\frac{c'}{c}$ of the two specific heats for air.
k' „ „ „ „ for mercury gas.

Then we have

$$k' = k\left(\frac{l'}{l}\right)^2 \frac{t'}{t}\, d.$$

If k for air was taken at $= 1{\cdot}405$ according to Röntgen, then by seven definite experiments, at different degrees of saturation of the mercury vapour, and three different sets of apparatus being employed, it was found on the average that

$$k' = 1{\cdot}67.$$

The results of the different experiments never deviated more than one per cent. from this value.

If the specific heat c at constant volume for air is taken as $= 1$, then it follows that c for mercury

$$c = 0{\cdot}60.$$

W.

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* See NATURE, vol. xii, p. 88.

AMONG THE CYCLOMETERS AND SOME OTHER PARADOXERS

NO notes have been handed down of the conversation between Erskine and Boswell, whilst strolling in Leicester Fields, on squaring the circle. There is on record, however, Boswell's small joke, "Come, come, let us circle the square, and that will do us good."

The subject is one that has occupied the thoughts of some few from the earliest times of geometrical history, and there are some now fascinated by it at this date, when we have—

> "on the lecture slate
> The circle rounded under female hands
> With flawless demonstration."

Old Burton advises him that is melancholy to calculate spherical triangles, square the circle, or cast a nativity. A popular novelist ("Aurora Floyd," chap. iv.), describing one of her characters "who was an inscrutable personage to his comrades of the 11th Hussars," says he was, "according to the popular belief of those harebrained young men, employed in squaring the circle in the solitude of his chamber."

To say of a man that he is a circle-squarer will make an ordinary mathematician shrug up his shoulders and indicate expressively that there is, in his opinion, a screw loose somewhere. Having had some slight acquaintance with the writings of a few of the race forced upon us, we propose here to pass them under review, generally contenting ourselves with letting them speak for themselves, for thus shall we possibly most effectually confute their absurdities, at least in the judgment of our mathematical readers.

De Morgan, the great exposer of circle-squarers, trisectors, *et id genus omne*, has, after Montucla, stated ("Budget of Paradoxes," p. 96) that there still exist three ideas in the heads of this race—(1) That there is a large reward offered for success; (2) that the longitude problem depends on that success; and (3) that the solution is the great end and object of Geometry. Some eight years ago we saw a letter from a Spanish Don of La Mancha, who offered to send an infallible method of squaring the circle; and within the last four months an application came to us from Sweden, in which the author stated that he had heard that the London Mathematical Society had offered a prize for the trisection of angles, and as he had after long working at the problem obtained a solution, he was ready to transmit the same, but his organ of caution led him to fear lest his communication might get into improper hands, and so he wished to know to whom to send the aforesaid solution. We need hardly say that the Society, in this matter imitating the example of the French Academy of Sciences and of our own Royal Society, has declined to receive any communication upon either of the above-named subjects or upon that of the allied problem, the Duplication of the Cube. This decision was arrived at in consequence of a bulky mass of papers on the circle problem having been laid before the President in the end of 1871. The author had previously submitted his papers to our own examination, and after some little perplexing we were able to indicate the point at which the author had tripped. We have heard nothing further of the solution, nor seen any of the elaborate figures since. We think it fair to state that we believe this cyclometer to have been an honest man and a good geometer. He had worked at the problem, off and on, some twenty years, and attacked it by the lunes of Hippocrates of Chios.

We have consulted the "Introductorium Geometricum" of Charles de Bovelles (Bovillus) in the 1503, 1507 (?), and 1510-1517 editions; and also his "Géométrie Practique" in the 1549 and 1555 editions; and we are disposed to think that De Morgan (B. of P., pp. 31, 32) is in error, possibly in this case following Montucla (for he says he has not seen the former work, and he makes no mention of the second), though all the copies of the "Introductorium" cited above contain the *De Quadratura* which De Morgan states that he has seen. Any how, all the constructions we have seen of Bovillus give $\sqrt{10}$, and not $3\frac{1}{8}$. This will readily be seen from the following:—Bovillus inscribes a square in a circle, and then *states* that the quadrantal arc is equal to the line drawn from an angle of the square to the middle point of one of the opposite sides. In his "Géométrie" he says of Cusa (whose views De Morgan states him to have adopted): "Il ha usé de dimensions infinies, lesquelles un géométrien ne cognoist, et ne confesseroit jamais estre possibles. Nonobstant, son invention est bonne et approuvee, tant par raison que par expérience." Nor do we find any account of his quadrature agreeing with that of a peasant labourer, but he states that he too had attempted the problem by another method (than that of Cusa), and not without success. Whilst standing on a bridge at Paris he noticed the carriage-wheels passing over the road; the fact that when the wheel has performed a revolution we have a straight line whose length equals the circumference of the wheel, suggested his solution to him, and on his return home he easily got his construction, which is this: Divide a radius of the circle into four equal parts, produce this radius through a fourth of its length; join the extremity of this line with an extremity of the diameter at right angles to the radius, and with the point as centre and this distance as radius describe a circle; the portion of the tangent at the extremity of the selected radius cut off by this circle, he says, equals the semi-circumference. It will be seen that this is the same value as that given above. Bovillus, also, in a *libellus de mathematicis supplementis* (1509), gives a third construction, which leads to the same value.

Before leaving this writer we ought to state that he attributes the first construction we have given to his friend M. Achaire Barbel, a man "ingenious at new inventions of use in geometry." It is with considerable diffidence that we have ventured to go thus into detail, but it seems to us that De Morgan had fallen into error in the case of this early writer.

We propose now to take up the subject at the point where it is left in the "Budget," constantly regretting that the hand which so vigorously lashed the offenders in this line now lies cold. Here we must give place to that arch circle-squarer, Mr. James Smith. We shall deal tenderly, however, with his book, as we learn that he too has gone over to the majority and joined his former opponent. The book we have now before us is "Why is Euclid unsuitable as a Text-book of Geometry? This question answered and the Propositions of Euclid 8 and 13, Book VI., proved to be erroneous by Heterodox Geometry." (Motto—"Magna est veritas et prævalebit." London: Simpkin, Marshall, and Co., 1871.) The editor, whose name does not appear, in an address to the reader, states that Geometricus, a principal correspondent in the pamphlet, is "an intimate acquaintance and almost in daily communication with Mr. James Smith, the well-known author," &c. Geometricus became a convert to Mr. Smith's views. He has no niche in the "Budget:" were we not informed to the contrary, we should have been disposed to say that Geometricus and Mr. James Smith were one and the same person. The first fifteen pages are mainly devoted to a correspondence between Geometricus and the Rev. Dr. Jones, if that can be called a correspondence in which the writing on one side is copious and on the other confined to simple acknowledgments of receipts of letters.

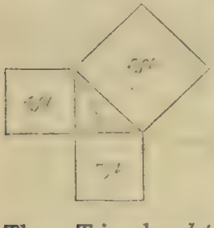
The doctor was singled out for this honour in consequence of his having written an able pamphlet "On the unsuitableness of Euclid as a Text-book of Geometry." Geometricus was delighted at the appearance of this work, thinking now at last "here is a recognised mathematician, who has got out of the groove and who can see a geometrical truth by whomsoever propounded;" but alas! he is soon disappointed, and finds that, as in Mr. Smith's experience, directly a mathematician is driven into a corner, he invariably gets out of it by pleading pressing engagements, want of time, &c., "and so a great and important scientific truth—it may be—is born to blush unseen," &c. He then sends James Smith's works (which we said above had converted himself), and now the redoubtable champion of "$\pi = 3\frac{1}{8}$" himself descends into the arena, and must have given the doctor a pretty lively time of it, from the 13th of April to the 10th of June, 1871, as he assails him in six long letters, with diagrams, occupying nearly thirty-three octavo pages of print. Much of what had been written in the "Athenæum Budget of Paradoxes" is brought up and the Smithian value maintained, for though this incontrovertible solution "may not be admitted by you or Clifford (alluding to Prof. Clifford's paper 'On an unexplained contradiction in Geometry,' read before the British Association), or any such like mathematicians of the present age, I can afford *to bide my time* and trust to posterity doing me justice."

This is the main portion of the pamphlet; there is, however, occasional sparring, both on the part of Geometricus and of Mr. Smith, with the editor of (and some writers in) the *Mechanics' Magazine*. In an appendix a correspondent recommends J. S., "now poor De Morgan (who made you look so rediculous [*sic*]), has departed from this life, there are still some great men left—Prof. Sylvester. Try him, Smith; if you convert that gentleman to your $3\frac{1}{8}$, I will give in *humbly*." Similar advice is given by the same writer in a second letter. The whole book is provocative of much amusement, and is quite of a piece with J. Smith's previous writings.

At the time of writing the previous remarks, we were under the impression that the "Budget" had exposed "Cyclometry and Circle Squaring in a Nutshell, by a member of the British Association for the Advancement of Science." This we at once found was not the case when the pamphlet was lent us by a friend. As we have devoted sufficient attention to Mr. Smith, we may shortly say that it is in octavo form, forty-four pages, and contains letters written between 24th October 1870 and January 1871; that is, immediately preceding the earliest date in the work we have noticed above. The correspondents are A. E. M. (is this the E. M. of the "Budget"?) and S. B. J. This last is another signature, we find, for the pertinacious Smith, who has figured elsewhere as "Nauticus," and wherefore not as "Geometricus"? The "Budget," though it does not discuss this *brochure* individually, has well demolished it by anticipation.

The close of the work is of a prophetical cast. "It is more than sixty years ago since an astronomer of recognised authority—who repudiated the idea that I could solve the problem of 'squaring the circle'—said to me: '*A bright day will have dawned on the astronomical world if ever the* EXACT *ratio of diameter to circumference in a circle shall be discovered.* The day will arrive when it will be said: 'In the nineteenth century of the Christian era—that remarkable century of invention and discovery—darkness still overshadowed the mathematical world. Scientific truth is, and ever has been, a plant of slow growth, but *Magna est veritas*, &c.'" It is to be hoped that the good man has not left his mantle behind, and that "Geometricus" and he were really one and the same.

Mr. John Davey Hailes has a place in the "Budget" (pp. 339, 340). He has not, so far as we know, touched upon the squaring of the circle, but possibly he is approaching that as the termination of his labours. We have before us five slips. The first addressed "To the Scientific of University College, London, 1871. The Curve a Progressing Wheel Curve. A *wheel* four feet diameter with a *nail in its rim*: when *traversing forward*, the *nail will form a curve, and much longer than the circumference of the wheel. Query: How much longer?* and what must be the DIAMETER of a circle—*for a part of the said circle to* SHOW THE SAID CURVE?" And then there follow two other geometrical questions, the one to divide a trapezium into two equal parts. On the back is pasted (all in writing): "'A Problem within a Problem. History record (*sic*) Pythagoras discovered the demonstration of the three squares to surround a Right Angle Triangle; the Two smallest when added together to equal the largest of twenty-five square Feet. I *ask* to find the *Dimentions* to demonstrate the Three Triangles *dotted out* into proportionally *un*equal parts, that when added to each square they produce the same result; viz. Two to equal the largest Figure.



> "N.B.—From the Figures 3, 4, and 5,
> They can be wrought perfective."

Dated Oct. 2, 1871.

So far there is not much harm in J. D. H.

Another slip addressed, in ink, "To University College, London," is a bit of Hailesian Astronomy, and is, "Astronomy is Paradoxical." The N.B. is of interest in the light of the recent Transit Expeditions. "Those Transit of Venus measurers *that try for the distance* of the sun by Paradox, are in error. Let them try to find *the distance by demonstration. I say it can be done*." The back of this page is devoted to "Astronomy and Longitude," and opens with the following doggrel:—

> Science the Lock of Bible Truth, all the Works Divine,
> Magnetic Key, unlock the Truth, and give *true Mean Time*.
> In the Time of Joshua the *Sun* stood over Gibeon, the Moon over Azalon;
> It was at the *Summer Solstice*, 2548 *from Adam*, DISPROVE WHO CAN?
> The Sun began to go back on the Dial of Ahaz at 40′ past Noon.

This last line is in ink. We have then a rule to find true longitude at sea by time, sun, and moon. The spelling is a caution, and the calculation a fitting companion. This is dated Oct. 16th, 1870; the former page Oct. 6th, 1871. Our last document from Mr. Hailes was sent to the British Association, 1868, and is entitled "My Calculated Time of Christ's Crucifixion, A.D. 30," with a number of dates: "And now I challenge all the astronomers in the world *justly* to dispute my above-given times for the above-given events." Verily, Mr. J. D. H. believes wisdom will die with him. Stand down! you will not do much harm, Mr. Hailes.

Mr. W. Upton, B.A. (B. of P., pp. 256-258) brought out in 1872 (E. and F. Spon), "The Circle Squared: Three famous Problems of Antiquity geometrically solved—1. The Quadrature or Circle Squared. 2. Diameter definitely expressed in terms of the circumference. 3. The circumference equalised by a right line. The whole rendered intelligible for arithmeticians as well as for geometers, and adapted for the higher classes in schools of both sexes, private students, collegians, &c." We think the day is not very near at hand when this subject will occupy the minds of schoolboys; the present generation have enough to do to secure time for the study of the elements in the "Conflict of Studies" which is being now waged. Mr. Upton, if now living, must be in his 83rd year, and can hardly be expected to write much more on this subject. In his preface he acknowledges to previous failure with respect to the trisection, "but has it now complete." (De Morgan demolished his former essays; one we have seen appears to depend upon a construction familiar to practical geometers. The neatest of practical methods we believe to be that hit upon by J. J. Sylvester, F.R.S., recently referred to in the columns of NATURE.) His aim (in the quadrature) has been at *practical* utility, not rigidly subject to all the extreme niceties of mathematical strictness. The more general treatment he has not gone into on account of the expense (he has not apparently the purse of a James Smith or a "Kuklos") He pledges himself to the satisfactory fulfilment of all that the following advertisement sets forth:—"1. The *full* development of the Quadrature, analytically and synthetically, in its threefold aspect—arithmetical, geometrical, and trigonometrical; containing—2. The so greatly coveted and despaired of desideratum of equalising a circular segment by a rectilineal figure, which determines at once the complete solution of the Quadrature. 3. An appendix, with diagrams, &c." All this to be published on or before Jan. 1, 1873, or much sooner if a sufficiency of *early* subscription warrants it. This work we have not seen; we infer, then, that there were not found eighty subscribers of sufficient faith in Mr. Upton's word and sufficiently interested in the question to come down with the requisite 3*s*. 6*d*. each. What an opportunity for a liberal-minded man! A trifle of 14*l*. in the one scale, and in the other a vexed question set at rest. Nor is this all; he could, too, satisfactorily account for the real origin and inspired nature of mythology, but for the present he confines himself to the more immediate subject. "Certain Hebrew letters and Greek mythology, nay, even Scripture itself, seem to bear distinct allusions to matters touching upon the origin of the square and circle." He winds up with a singular excursus upon the Hebrew ל "distinctly representing the square and circle; the *level* line answering for *base* of the one and *diameter* of the other; the perpendicular for the adjoining side of the square; and the curve for a quadrant of the circle: each with an appearance of *string* at the extremity to intimate its being carried on to *completion*." There is a "Supplement" (diagram and five pages, *free of charge*), from which an estimate of the value of the work may be got on the author's own showing: "The *precise* difference is therefore *not* equivalent to the impression of a pin's point; so that the author considers himself fully justified in looking upon the two areas as *arithmetically* equal. Moreover, in a *geometrical* solution, which is the *real* object of the problem, it is evident that so *invisible* a difference can have no possible effect."

Again, if he should be enabled to publish his proposed treatise, he can "show by three or four *distinct* but *concurrent proofs* that the circle itself not only admits of, but—more surprising still—actually suggests the formation of a right-lined figure equal in area to the circular segment belonging to each quadrant! This is what may indeed be esteemed as the *true secret*, the *virtual key* of the Quadrature; which the author will give to his readers and apply for them in the annexed diagram. He would have reserved the *fact* till he could have given it with the several proofs *complete*. But, as the fact itself, and its application to the diagram, ought to prove sufficient to produce conviction as to the truth of his assertion, he will proceed to apply it without further preface." We gather from his remarks that they turn upon the lengthening of a line by a *point* from a pencil which can make no *perceptible* difference in the geometrical construction. It seems only necessary to make this statement, and leave our mathematical readers to draw their own conclusions therefrom. (*To be continued.*)

INTERNATIONAL METEOROLOGY*

IT may be truly said that all the large questions which fall within the province of meteorology can only be adequately discussed by data collected in accordance with some well-devised scheme of international observation. What is required is the means of giving an accurate general representation of atmospheric pressure, temperature, humidity and aqueous precipitation, together with the movements of the air as indicated by the direction and force of the wind, and of the phenomena more immediately connected with these movements. Of these last, the more important are clouds, their species and motions, and electrical and auroral manifestations.

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* Report of the Permanent Committee of the First International Congress at Vienna, for the year 1874 Printed by authority of the Meteorological Committee. (London: Stanford, 1875.)

These large inquiries naturally fall into two groups. The first group is concerned almost exclusively with the great movements of the atmosphere, and it is the adequate investigation of these inquiries which is aimed at by the United States Government in their great scheme of observations made at the same *physical instant* over the whole globe. This scheme may be called *cosmopolitan.*

The second scheme may, in contradistinction to the above, be called *international.* It includes those inquiries which deal with the large and vitally important subject of comparative climatology, or a comparison of the climates of different countries and regions, and of their meteorology generally, inclusive of the great movements of the atmosphere over a restricted portion of the globe, such as the United States, the North Atlantic, or Europe. It is altogether essential to the discussion of those inquiries which fall under this head that the observations be made at the same *local time* and with instruments so constructed and placed as to give results strictly comparable with each other. It is evident that the exposure of the thermometers, including their immediate surroundings and height above the ground, must be uniform in all countries; otherwise the observations, being incomparable, cannot be used in questions of international meteorology.

Of the recurring meteorological phenomena which first and most imperatively require to be dealt with internationally, both from their importance in atmospheric physics and from their intimate bearings on animal and vegetable life, are the daily changes which take place in the temperature, humidity, pressure, and movements of the atmosphere from 9 A.M. to 3 P.M. With observations at these hours, together with the daily maxima and minima of temperatures from a network of stations well spread over Europe, we should be put in a position of being able to inquire, with some hope of success, into the influence exerted on meteorological phenomena by different latitudes and elevations; by the Baltic, Caspian, Black, Mediterranean, and Adriatic Seas, the English Channel, and the Atlantic; and by the Swiss Alps, the mountain ranges of Great Britain and Norway, the scattered hills of Ireland, the elevated plateaux of Spain, and the extensive flats of Germany and Russia. We entirely concur with Prof. Plantamour in thinking that during recent years the study of the movements of the atmosphere has been too exclusively directed with a view to the application of the results to the prediction of storms on the coasts and to the system of storm-warnings, and that other points of view have been completely abandoned (Report, p. 58). It is right, however, to add that this neglect may be excused on the ground that, as there is an entire want of uniformity in the hours and modes of observing in the systems of meteorology as pursued in the different countries of Europe, the data for the investigations of nearly all the important questions of international meteorology do not exist.

It was a widespread feeling of a requirement of uniformity of procedure in the prosecution of meteorological researches in different countries which led many to look to the Congresses of Leipsig and Vienna as likely to secure this result; and it is a matter of regret that at these meetings nothing was done to bring about uniformity in the hours and modes of observing. Doubtless the question of international observations was under discussion at Vienna, but the feeling of the delegates regarding it, as indicated by the state of the vote and the large number who abstained altogether from voting, was such that the only resolution arrived at was this, viz.: "That the best form of publication for the stations selected for international objects should be determined by the Permanent Committee, after consultation [*nach Anfrage*] with the directors of the central institutes." *

The matter accordingly came before the Permanent Committee at their meeting at Utrecht in September 1874, and after numerous explanations and a long discussion they unanimously resolved on a form for the publication of observations made for international objects (p. 7). This resolution is now being carried out by several of the countries represented at the Vienna Congress.

With reference to this resolution, however, it is to be remarked that (1) no provision was made by it for the observations being made at the same hours of the day; and as a matter of fact, the observations in the British Isles in connection with the scheme are 9 A.M. and 9 P.M.; in Russia, 7 A.M., 1 P.M., and 9 P.M.; in Norway, 8 A.M., 2 P.M., and 8 P.M.; in Italy, 9 A.M., 3 P.M., and 9 P.M.; in Austria, variously, and so on.

(2) No provision was made for securing uniformity as regards the vital question of the exposure and position of the thermometers, without which comparability is impossible.

(3) The forms adopted, both for the daily observations (p. 10) and for the monthly results (pp. 47-50) are in several respects defective, inasmuch as they do not include some of the more important data required in international inquiries.

The result will only be the printing of various sets of observations styled international, but which are not international—being, in truth, taken at their very best, merely national. By observations so made, no international question of meteorology can be satisfactorily discussed, and many international questions of the first importance, both practical and scientific, cannot even be attempted to be discussed.

When the subject was before the Vienna Congress, Plantamour urged the necessity of drawing a distinction between observations referring to the special study of the climate of each country, and those which are intended to indicate the simultaneous condition of the atmosphere over the whole surface of the earth (Report of Vienna Congress, p. 35). Until this be done, or until some such scheme as we have here indicated has been considered and agreed upon, it would be a mistake in meteorologists co-operating in carrying out a scheme which, while called international, completely fails to furnish the data required for international inquiries.

The only wise course the Permanent Committee can take at their next meeting is to rescind this resolution, as they have already virtually rescinded (p. 8) the resolution regarding rain-gauges all but unanimously passed at Vienna; and after consideration of the whole question to make provision that the instructions given them by the Vienna Congress with regard to this matter be carried out, viz., that no resolution be come to till they have consulted the directors of the central institutes of the different countries; by which means they will furthermore be put in a position to propose a scheme which has been well matured, and therefore of such a character as will enlist in its behalf the general co-operation of meteorologists.

NOTES

WE can only this week join in the universal expression of regret at the death of Sir Charles Wheatstone, which took place at Paris on the 19th inst., at the age of seventy-three years. Inflammation of the chest was, we believe, the immediate cause of the sad result. The Paris Academy showed the greates interest in Sir Charles during his illness, and previous to the removal of his body to London a religious service was held at the Anglican chapel in the Rue d'Agueneau, at which a deputation from the Academy was present. MM. Dumas and Tresca delivered addresses, which will be published in the *Comptes Rendus.* Sir Charles was buried yesterday in his family burial-place at Kensal Green. We shall give a memoir in an early number.

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* Protocol of the Ninth Meeting of the Congress.

THE following changes are proposed to be made for the ensuing session in the Council of the London Mathematical Society :—Profs. Cayley and Sylvester, having served their term of office, become ordinary members, and the Council recommend that their places be filled up by Lord Rayleigh, F.R.S., and Mr. W. Spottiswoode, F.R.S. Dr. Henrici, F.R.S., and Mr. H. Martyn Taylor are put in nomination to fill up the vacancies caused by the withdrawal of Mr. R. B. Hayward and Mr. W. D. Niven.

THE anniversary meeting of the foundation of the French Institute by the executive directors of the first French Republic was celebrated as usual on the 25th of October. The president was M. Lefuel, a member of the Academy of Fine Arts: he was assisted by delegates of the other academies. M. Lefuel had to perform the duty of awarding the great biennial prize (see vol. xii. p. 526) for 1875 to M. Paul Bert, member of the Versailles Assembly and a Professor of Physiology at the Sorbonne, for his discoveries relating to the part played by oxygen in the act of respiration. Although the report was presented to the Academy of Sciences at a secret sitting, it is expected that it will be published shortly, as the noblest part of the award is not the gift of a handsome sum of money, but the reasons why the prize had been adjudged to the candidate. After this the report for the prize established by the celebrated Volney was read at full length, and three lectures were delivered. The last one was by M. Mouchez, the new member of the Academy of Sciences, on the Venus Transit Expedition to St. Paul. The brave captain read it in plain sailor-like fashion and with much humour, and met with a most favourable reception.

THE Congress of Meteorologists, which was to have been held at Poitiers at the end of October, has been postponed for a month, and will be held on the 19th, 20th, and 21st Nov. next. It is to be styled the "Meteorological Congress of Western Oceanic France." All the departments situated within the space bounded by the Dordogne, the Atlantic, the Loire, and the central mountains of France, together with the Council of the Observatory of Paris, will be represented on the occasion. Among the representatives who will be present are MM. Belgrand, Renou, de Touchimbert, de Tastes, de la Gournerie, Lespiault, Raulin, and Leverrier, who will preside. Delegates from the departments of the regions adjoining are invited to be present to assist in laying the basis of a common understanding among the different regions in matters referring to meteorology.

A REUTER'S telegram, dated Rome, October 23, states that Mr. J. Norman Lockyer and Major Festing had arrived there, deputed by the British Government to propose to the Italian Government to send to the Exhibition at South Kensington in 1876 a collection of the instruments used by Italian professors in recent important astronomical observations.

PROF. BOYD DAWKINS, F.R.S., who left early in June for Australia, has returned to England *viâ* the Rocky Mountains Railroad and New York. The duties of the Geological chair at Owens College have been taken during his absence by Mr. C. E. De Rance, F.G.S., of the Geological Survey of England and Wales.

THE Commission on Vivisection have been meeting constantly during the past and present weeks, and have examined a considerable number of witnesses.

IT is announced that the preliminary works for the Channel Tunnel are to be commenced this week near Calais. A shaft will be sunk to a depth of 100 metres.

AS zoologists are not likely to look in the Transactions of the Society of Biblical Archæology for anything concerning their own studies, especially in a paper entitled "The Tablet of Antefaa II.," it may be as well to mention that this paper, by the learned president of the society, Dr. S. Birch, of the British Museum, in the last issued number of the Transactions (vol. iv. part i.), contains an interesting account, with numerous illustrations, of the different breeds of domestic dogs kept by the ancient Egyptians. It would appear from the drawings preserved on the walls of the tombs, that the variations of this animal in those early days were quite as well marked as those that may be seen at a modern dog-show.

THE Geographical Society of Paris held its first semi-monthly meeting of session 1875–1876 on the 20th of October; more than 190 members were present. The chair was filled by M. Delesse, the president of the central section. The correspondence was unusually long and interesting, and it is evident that geographical studies are advancing in France.

AN expedition under M. Largeau has been fitted out by the French Chambers of Commerce and private subscriptions to proceed to Rhadames from Algiers, and open communications with Soudan and Timbuctoo. The expedition is already on its way. A French paper, the *Rappel*, has sent a special correspondent with M. Largeau; this is perhaps the first time that any French journal has taken such a step.

NEWS has been received from the French Gaboon expedition under MM. Marche and Brazzi. These two gentlemen had arrived at St. Louis and selected a number of Laptots to accompany them in their excursions. The expedition is to last several years. A Government steamer was to conduct them from St. Louis to Gaboon.

A FRENCH expedition is being fitted out to make a "Tour du Monde" in ten months. The excursionists are to visit India, Japan, the interior sea of Japan, Chinese ports, Australia, &c. A special library, with instruments, will be placed on board. The members of this expedition will be exclusively of the male sex. The fare is to be 800*l.*, everything included. The Geographical Society will superintend the management of the enterprise, although it will be supported by private funds and is altogether a private speculation.

THE Marquis de Compiègne, the African explorer, has ftle for Cairo, where he has been appointed by the Khedive the acting secretary of the newly-established Khedival Geographical Society.

THE *Times* special correspondent at Suez, under date Oct. 26, telegraphs as follows with regard to African exploring expeditions :—"Despatches of the 14th and 20th of August, received yesterday, report that Lieut. Gordon was in Appudo with the steamer. The Kabba Regga people were intriguing. Linant saw Stanley, who had traversed Lake Victoria from south to north alone, at M'tesas. Cameron was at Tanganyika for eight months, trying to go the western route between Uganda and Zanzibar, which was interrupted by the Karaque tribe two degrees south. Subsequent despatches report the death of Linant in a fight with the Kabba Regga people. Lake Victoria is very large, and full of isles."

WE announced some time ago that the Italian Geographical Society was organising an expedition for African exploration. The Society has already raised 70,000 lire, which it expects its honorary president, Prince Humbert, to raise to 100,000 lire (4,000*l.*) The *Times* Milan correspondent sends additional details. The Italian expedition is to be divided into two sections; one is to set out from the Gulf of Aden for Tajurra, or Berbera, or some other port on the eastern coast of Africa, proceed to Shoa, and thence to Kaffa; and from this great slave market it would make its way through an unexplored region to the central lakes, studying the hydrographic course of the eastern Nile. The other party would take its start from Khartoum, and, exploring the region lying between Monboottoo and the Victoria Nyanza, push on, if it be practicable, as far as the great valley of Lualaba, discovered by Livingstone. The first-mentioned section of the expedition will be commanded by the Marquis Antinori, one of the vice-presidents of the Geographical Society, a distinguished ornithologist, who has spent several years in Central Africa, and whose travels in that region have won him a widespread reputation. He is now about seventy years old. The other section will be under the guidance of Ademoli, also familiar with the districts he proposes to explore, a young, brave, and strong man, known for his enthusiasm in the work of discovery, to which he has devoted himself.

FURTHER correspondence from members of the English Arctic Expedition confirms the news brought home by the *Pandora* that an unusually easy passage had been made to within 100 miles of the entrance to Smith Sound, and it is even expected that if circumstances continue equally favourable the pole may be reached this year. The expedition is not expected home, however, till the end of 1877. On July 23, the *Alert* met with the first accident; she went on shore on a small island off Kingitok, but was floated off without injury as the tide rose.

LAST week we gave an abstract of Lieut. Weyprecht's paper on the principles which ought to guide Arctic exploration. Now it is stated that the Scientific Commission appointed by the German Government has reported, we believe in consequence of this paper, against the expediency of a fresh Polar Expedition, but has recommended the establishment of stations of observation in both hemispheres.

A PAPER of considerable interest, by Dr. Daniel Wilson, has been reprinted from the *Canadian Journal*. Its title is "Hybridity and Absorption in relation to the Red Indian Race." Dr. Wilson, while of course admitting the patent fact that the American Indians, like most other barbarous races, have largely melted away before the white races, thinks that in accounting for this too much stress has been laid on mere extermination. He adduces data to prove that a very considerable proportion of red blood has been absorbed into the whites of North America, and that especially in the Canadian Dominion this shows itself in the physiognomy of all classes. It would be difficult, he believes, to find either in the United States or in Canada many Indians of pure breed. In Canada half-breeds are the almost universal representatives of the former Indian tribes, and many of them are settling down to a steady civilised life. In short, Dr. Wilson has what appears to us a well-founded belief that the aborigines of North America are being gradually absorbed into the dominant race, and that in course of time they will have become as integral a part of the population as any one of the elements which may be traced in the population of Europe, and that their physical and mental characteristics will tell upon the American character—just as Melanochroic attributes have left marked traces on the intrusive Xanthochroic European peoples. Fortunately the evidence gives good ground for believing that this influence is decidedly good, physically and intellectually. The characteristic "Brother Jonathan" face, which is generally attributed to influences of climate, soil, food, &c., Dr. Wilson is inclined to attribute to a decided admixture of Indian blood; probably both causes have had to do with it. Dr. Wilson rightly advocates the most judicious and humane treatment of the Indians both by the U.S. and Canadian Governments.

THE opening lecture of this session's Manchester Science Lectures for the People, the charge for admission to which is only one penny, was given on Tuesday last by Capt. Davis on "Arctic Discoveries." The other lectures are as follows:—Prof. Rucker on "Soap Bubbles;" R. Bowdler Sharpe, F.L.S., on "The Birds of the Globe;" Prof. J. Martin Duncan, F.R.S., on "The Great Extinct Quadrupeds;" Prof. Thorpe, F.R.S.E., on "Cavendish and his Discoveries;" Prof. Ferrier, F.R.S., on "The Functions of the Brains;" Prof. Henry E. Armstrong, on "Food;" William Pengelly, F.R.S., on "The Age of the Men of Kent's Cave." Part II.

A CIRCULAR, signed by Mr. W. Melton, who is judicial assessor on the Gold Coast, was issued last month by order of the Governor, "To the native kings, chiefs, captains, headmen, and principal men of the Gold Coast Colony," pointing out that "it is most desirable that the Gold Coast Colony should be well represented at the forthcoming International Exhibition at Philadelphia," and asking them to give all assistance in their power in sending contributions and collecting articles illustrative of the countries and districts over which they preside. Mr. Melton has issued a classified schedule of articles suitable for exhibition. Department I. Materials in their unwrought condition, mineral, vegetable, and animal. II. Materials and manufactures, the result of extractive or combining processes. III. Textile and felted fabrics, apparel, costumes, and ornaments for the person. IV. Furniture and manufactures of general use in construction and dwellings. V. Tools, implements, machines, and processes. VI. Boats and sailing vessels. VII. Apparatus and methods for the increase and diffusion of knowledge. VIII. (Not represented). IX. Plaster and graphic arts. As the arrangements are, we are told, in vigorous hands, and it is announced to the "native kings, chiefs," &c., that they may be reimbursed for any outlay they make, it is expected the collection from this colony will be extensive and interesting. In connection with this, Schweinfurth's "Artes Africanæ," just published, is of interest: we shall give an early notice of this work.

IN reference to a recent note, p. 461, we are glad to see that at the Brighton meeting of the Social Science Association a resolution was passed requesting the Council to communicate with the authorities of the Science and Art Department of the Privy Council, suggesting the desirableness of making "Foods, their uses and preparation," the subject of examination.

IT seems that a good deal of the tobacco used in the manufacture of the so-called Havana cigars in Germany comes from Colombia, principally from Jiron, Ambalema, and Palmira, and that its quality is not of the first mark. Tobacco is also cultivated in the State of Bolivar, and is exported for a similar use.

MR. AMOS SAWYER contributes a short though interesting article to the *Transactions of the Academy of Science of St. Louis* on the cause of climatic change in Illinois. During the last twenty years, he says, the climate has been slowly, but surely, changing from wet to dry; and although this change has been beneficial from a sanitary point of view, agriculturally considered it has been, and will hereafter prove to be, a great obstacle to the successful cultivation of the soil. The most important agent, in Mr. Sawyer's opinion, is what he calls the aqueous agent. The chemical and mechanical effects of this agency are constantly at work, and the result is plainly visible in the deepening of the channel of all the small streams. At the present time all the prairie land is in cultivation, or used as pasture; the ponds and small lakes have become so filled up that they contain less than half the former amount of water; the stock now consumes the reeds and marsh-grass, exposing the water to the direct rays of the sun, thereby promoting evaporation, so that by midsummer even the mud in their basins has dried to a hard crust, and a change in the temperature during the heated term brings, as a rule, a cool, dry atmosphere instead of rain, as in former years. Mr. Sawyer goes on to describe the large increase in the consumption of water by domestic animals. In this State at the present time there are at least "three million horses, cattle, and mules, and five million hogs and sheep, and they will consume not less than *seventy million gallons* of water every twenty-four hours—quite a lake of itself." This, surely, must be a misprint, or American animals are very thirsty beings!

A CORRESPONDENT of the *Aberystwith Observer*, the Rev. James Lewis, of Llanilar Vicarage, writes as follows to that journal:—"Whilst returning from service at the parish church of Rhostie, about 8.15 P.M. on Friday, the 24th ult., in company with two members of the congregation, my attention was called to a remarkably strange phenomenon. In walking across a field on the farm of Cwmclyd, it was noticed that our footsteps were marked by a peculiar light, which could be traced back for several yards, each footprint being as distinctly marked on the ground as when one walks in snow. When we got into the adjoining field the light disappeared until we came near to the end of it, when it was observed that our footsteps were again marked by the same luminous appearance. In colour the light was similar to that of phosphorus rubbed on a wall in a dark room, or a mass of glow-worms, of which insect, however, there was no trace on the surrounding ground."

IN the *Bulletin International* of the Paris Observatory for the 21st inst. appears an interesting note by M. de Lagrenè on the thunderstorms which have occurred in the department of Haute-Marne during the seven years ending 1874. In this department the average annual number of thunderstorms is 87, of which 25 occur in July, 20 in May, and 14 in June. During the six months from October to March inclusive the mean annual aggregate is only six. The geographical position of Haute-Marne is an important one as regards these electrical phenomena, about which so very little is yet known, and this Departmental Meteorological Commission is doing good service in contributing its share in the work of collecting data on the origination, intensity, and rate of propagation of thunderstorms, and the manner in which they are influenced by the winds prevailing at the time, by the contour of the ground, and by forests.

WE have received the first number of the *Iowa Weather Review*, September 1875 (pp. 20), which has just been started by Dr. Gustavus Hinrichs, from which we learn that the system of rain observations set on foot by him, as explained in a recent notice in NATURE, is only the beginning of a more complete system by which it is hoped that the whole meteorology of this important State will be adequately and systematically observed and turned to practical account in the interests of the people. There is an idea shadowed out in the prospectus by which, if gone into and developed, the United States will be divided into meteorological districts or regions similar to what is now being done in France, and which is really the only means by which many highly important questions can be properly investigated. Dr. Hinrichs gives the monthly rainfall for the months of past years' observations, as well as the monthly means, at six places in the State, and sends a carefully compiled monthly report of his own observations made at the laboratory of the Iowa State University at Iowa City, the amounts and averages of each month being compared with the results of previous years' observations.

THE additions to the Zoological Society's Gardens during the past week include a Binturong (*Arctictis binturong*) from Malacca, presented by Captain A. R. Ord; a Wood Owl (*Syrnium aluco*), European, presented by Mr. F. Brannd; a Missel Thrush (*Turdus viscivorus*), European, presented by Mrs. Watson; a Grey Wagtail (*Motacilla boarula*), seven Picked Dog Fish (*Acanthias vulgaris*), European, purchased; a Cape Buffalo (*Bubalus caffer*) born in the Gardens.

ON THE VARIATIONS OF THE ELECTROMOTIVE FORCE OF A NEW FORM OF LECLANCHÉ'S CELL

A NEW form of Leclanché's cell has been constructed by Dr. Muirhead, and is supplied by Messrs. Warden, Muirhead, and Clark.

In this form the carbon and black oxide of manganese are packed in the outer case around a glazed porcelain jar perforated with holes about one-eighth of an inch in diameter, the jar containing a zinc plate bent into the form of a cylinder.

The advantages gained are that a much larger surface of zinc is exposed and the perforations of the jar are in no danger of being choked up by deposition of chloride of zinc.

The following results may be of some interest as showing how the electromotive force of this cell varies when it works for a considerable time through circuits of various resistances.

A circuit of known resistance was formed, through which the battery worked, and two points in this circuit were attached to the poles of a sawdust Daniell's cell, so as to form a branch circuit in which a galvanometer was included; one of these two points was then moved along the circuit until the galvanometer showed that there was no current through the Daniell; when this is the case the E.M.F. of the battery is to that of the Daniell in the same ratio as the resistance of the whole circuit to that of the part between the points of attachment of the Daniell.

A set of coils was used by which the resistance could be adjusted to ·05 ohm, and by adding one of these coils to the common part of the circuit (so that the resistance of the whole circuit did not remain quite constant) a very small change in E.M.F. could be measured.

The current through the Daniell was always very small, and as it passed sometimes in one direction and sometimes in the other, the difference between the potentials of its poles must have remained very nearly constant.

In the circuits of small resistance it became necessary to take account of the internal resistance of the cell. This was found (for these circuits) to be generally between ·45 and ·46; it was subject to slight variations between these limits, but rarely exceeded them when the battery was worked for only two or three hours, although on leaving the battery circuited through 30 ohms for 20 hours it rose as high as ·525. The lowest resistance observed was ·420 when working through 10 ohms.

The following tables give the E.M.F. of the battery in terms of the Daniell:—

When the cell had been circuited through 10 ohms for 2 min., the E.M.F. was 1·320; for 3½ min., 1·314; for 5½ min., 1·304; for 13 min., 1·292; for 23 min., 1·283; for 34 min., 1·277. For 1h. 1m., 1·266; for 1h. 31m., 1·256; for 1h. 56m., 1·254; for 2h. 11m., 1·253.

When circuited through 20 ohms for 2½ min. the E.M.F. was 1·3465; for 4 min., 1·3420; for 5½ min., 1·3385; for 13 min., 1·3315; for 18 min., 1·3270; for 30 min., 1·3215; for 46 min., 1·3155. For 1h. 1m., 1·3095; for 1h. 22m., 1·3045; for 1h. 31m., 1·3035.

When circuited through 30 ohms for ½ min. the E.M.F. was 1·3702; for 2 min., 1·3608; for 3 min., 1·3585; for 4 min., 1·3562; for 10 min., 1·3500; for 20 min., 1·3446; for 26 min., 1·3404; for 28 min., 1·3391. For the next four minutes the E.M.F. was very unsteady. For 32 min., 1·3411; for 33 min., 1·3398; for 39 min., 1·3364. For 1h. 3m., 1·3318; for 1h. 14m., 1·3292; for 1h. 28m., 1·3211; for 23h. 30m., 1·2810.

When circuited through 100 ohms for 7 min. the E.M.F. was 1·4415; for 10 min., 1·4417; for 20 min., 1·4423.

No further change was observed at the expiration of one hour.

When the cell (after being insulated for 21 hours) was circuited through 3,200 ohms, after 1 min. the E.M.F. was 1·448; after 3 min., 1·450; after 18 min., 1·454; after 38 min., 1·459.

When the cell was short circuited through itself for two minutes the E.M.F. fell from 1·407 to 1·235. (These measurements were taken with the cell working through 3,500 ohms.)

On being circuited through 3,500 ohms for 23 min., the E.M.F. rose to 1·383.

More observations were made than those here recorded, readings being taken in some cases every minute, but the only irregularity observed was that noticed when working through 30 ohms.

In these experiments we may notice that when the battery was short circuited through 10 ohms, the E.M.F. after the first two minutes fell 4¼ per cent. in 1¼ hours; through 20 ohms it fell 3 per cent.; and through 30 ohms, 2¾ per cent., in the same time. But when circuited through 100 ohms and upwards, the E.M.F. increased with the time,* the percentage increment increasing with the resistance. Hence it appears not unlikely that there may be some resistance through which the E.M.F. will remain absolutely constant; should this be found to be the case, and should this resistance always remain the same, the battery will be very valuable when required to work through such a circuit.

It may be remarked that, in accordance with the usual rule, the E.M.F. of the battery increases with the external resistance.

The cell was insulated for a considerable time previously to commencing each set of experiments. S. A. SAUNDER

Cavendish Laboratory, Cambridge

OUR BOTANICAL COLUMN

EXOTIC TIMBER-TREES IN MAURITIUS.—Amongst useful plants that have been introduced into countries distant from their native habitats, the timber-trees are of some interest, inasmuch as beyond the proof of their establishment in foreign climates and soils, some time is needed to prove what effects the change may have on the quality of the timber itself, for on this alone depends the value of the experiment in a commercial point of view. It is, however, satisfactory to learn that some well-known timber-trees that have been introduced into Mauritius through the instrumentality of the Royal Gardens, Kew, are in a flourishing state. Thus, the mahogany (*Swietenia mahagoni*), one of the oldest and most valued of furniture woods, has made a very rapid growth, forming, in three or four years after the sowing of the seeds, trees about twenty feet in height, with stems from three to six inches in diameter. In India, likewise, the mahogany thrives well, and as a proof that the wood is valuable, it may be stated that a tree blown down in the Calcutta Botanic Gardens during the great cyclone realised over 1,000 rupees. Logwood (*Hæmatoxylon campeachianum*) is reported also to grow well in Mauritius, and it moreover makes excellent hedges, far superior, it is said, to hawthorn. It has been quite naturalised on the hills and waste lands in the vicinity of Port Louis, and annually produces large quantities of seeds.

BAMBOO AS A PAPER MATERIAL.—A good deal of attention has of late years been directed to new materials for paper making. Esparto has been one of the most successful of modern discoveries, and now we are told that the supplies of that useful substance are decreasing and must in course of time fail altogether. Where then shall we look for our future supplies is a question that has agitated many minds, and which has been answered frequently by references to the numerous fibre-producing plants of both the East and West Indies, Australia, &c. We know that in India the fibrous barks of many trees, and notably that of *Daphne papyracea*, are used for paper making; while in China and Japan, where paper is used for a much greater variety of purposes than it is in England, the barks of *Broussonetia papyrifera* and *B. Kæmpferi* are made into paper of every conceivable and indeed inconceivable form; for some specimens are so much like leather that it takes a critical eye to detect it, and others are such good imitations of crape and muslin that the same care is needed to determine their true nature. That the Chinese and Japanese excel in paper-making cannot be doubted, when we consider all their manufactures, and more especially that fine quality of paper known as India proof paper, which they make from young bamboos. The bamboo as a paper material in this country is a comparatively modern introduction; indeed, we can hardly say that it has actually become a commercial article, but there seems no reason why the stems of the bamboo, which in tropical countries is one of the commonest and fastest growing plants, should not be converted into *half stuff* and sent to England in almost any quantity. To make this material better known has been the aim of Mr. Thos. Routledge, in a little pamphlet of forty pages, which he has just issued. Mr. Routledge is no doubt able to speak with authority on the details of manipulation of paper stock in a practical, if not in a scientific sense; but it is not our intention to follow him through the subject, but simply to refer to some facts quoted by him as an illustration of the suitability of bamboo as a paper-making material, and to endorse to a certain extent some of those facts and suggestions. Thus, with regard to supply, it is well known that in most tropical countries bamboos of various species flourish to a considerable extent and are to the people of immense value, furnishing them with numerous articles of daily necessity; then again their growth is so rapid as to form a constant supply. With regard to the rate of growth, we read that at Gehzireh, the gardens of the Khedive of Egypt at Cairo, it has been known to grow nine inches in one night. At Sion House, the Duke of Northumberland's, stems of *Bambusa gigantea* have attained the height of 60 feet in twelve weeks; while at Kew, *Bambusa vulgaris* is recorded as growing in favourable seasons at the rate of eighteen inches per day; and at Chatsworth the same species has attained the height of 40 feet in forty days. For the purpose of paper-making the stems should be cut down in a comparatively young state, before they become too woody, and reduced to pulp or half stuff before being sent to this country.

SCIENTIFIC SERIALS

American Journal of Science and Arts, October.—This number contains the following two papers read at the Detroit meeting of the American Association for the Advancement of Science.—Address of Dr. John Le Conte, the retiring president.—A comparison between the Ohio and West Virginia sides of the Alleghany coal-field, by E. B. Andrews.—There is also a reprint from the *Philosophical Magazine* of Mr. Mallet's paper on the temperature attainable by rock-crushing.—In an obituary notice of Sir Charles Lyell, there is introduced an extract of a letter from Dr. Mantell to Prof. Silliman, in 1841, describing how Mantell and Lyell first met.—The original articles in this number are: On the arithmetical relations between the atomic weights, by M. D. C. Hodges.—A note by L. F. Pourtales recording the corals found at the Galapagos Islands.—On instinct (?) in hermit crabs, by Alexander Agassiz. This records how young crabs reared without shells during their growth, "made a rush" for them as soon as they were placed in the tank where they were living.—On Southern New England during the melting of the great glacier, Part ii. We reserve our notice of this till the paper is completed.

Geological Magazine, October.—The original articles are: The Geology of Central Sumatra, by R. D. M. Verbeek (superintendent of the Geological Survey of Sumatra). This is stated to be the commencement of a series of articles on the subject, published with the authority and assistance of the Dutch-Indian Government. The oldest rocks in this part of Sumatra are granites, granite-syenites, and syenites. Then follow sedimentary rocks classed as of Carboniferous or Permian age. "This oldest sedimentary formation of Sumatra can be divided into two parts. The lower portion consists of clay-slates with auriferous quartz-veins, marl-slates and siliceous schists; the upper part consists only of limestone, with some small beds of schists." There are quartz porphyries and greenstones, the age of which is not known, but they are probably older than the tertiaries. The tertiaries themselves are divisible into five groups. The trachytic rocks are younger than the tertiaries. Three clearly drawn sections illustrate the paper, and a list of principal papers on the geology of Sumatra is given.—On the origin of Coums, by J. G. Goodchild. That many of these cauldron-like hollows are due to the eddying of ice is the argument of Mr. Goodchild.—Dr. Walter Flight continues his "History of Meteorites."—Dr. Thomas Wright records the occurrence of the genus *Cotylederma* in the middle lias of Dorsetshire.

Poggendorff's Annalen, No. 8.—This number commences with an investigation by Karl Müller as to the pitch of the transversal vibrations of bars of gypsum, when these are saturated with different droppable liquids. It appears that the liquid does not act as a weighting of the bar, but enters into union with the molecules of the substance, diminishing the co-efficient of elasticity; and this is manifested in a fall of pitch, the fall having been greatest (in the cases studied) on imbibition with water, less with oil, and least with alcohol. It is greater the higher the specific gravity of the liquid. The change of pitch with alcohol and with oil was more regular than with water, and the regularity was almost perfect, if the changes of tone of the saturated bars were compared with one another, and not with the dry state.—Herren Kundt and Warburg continue the account of their researches on friction and conduction of heat in rarefied gases. Having experimented with air, hydrogen, and carbonic acid, they here show that the coefficients of friction are independent of pressure within the limits 750 mm. and 1 mm. mercury. With rarefaction under 1 mm. they could not sufficiently remove the vapour.—Dr. Oberbeck describes a method of determining the conductivity of liquids for electricity. The principle is briefly this:—Connect the ends of an induction spiral with a spark micrometer. Then, with a certain strength of inducing current, a separation of the balls may be found, at which sparks continuously pass; but on slightly increasing the interval they cease to pass. Next, connect the two ends of the spiral also with an uninterrupted branch line; it will depend on the resistance of this and the intensity of the inducing current, whether sparks will pass between the balls. If the line is short and of metallic wire, the spark current disappears, however near together the balls may be brought; but if it consist of thin tubes of badly conducting liquids,, a small approximation of the balls will reproduce the sparks. Thus the conductivity of liquids may be compared.—An improved construction of lightning conductors for telegraph-wires is described by M. Schaack. The line-wire and that of the telegraph-apparatus are connected respectively with two binding screws on pieces of wood which form opposite rims of a rectangular tin case containing water, and a loose coil of German silver wire, covered with caoutchouc, connects the binding screws through the water. The wire of the telegraph-apparatus, after passing through the apparatus, returns to the case, which is connected to earth.—There is also an account of M. Le Cour's valuable proposal for employment of tuning-forks in electric telegraphy.—M. Schneebeli continues his researches on the attraction and separation-time of electro-magnets, and takes occasion to describe Hipp's chronograph as recently improved.—Among the remaining papers may be noted one by M. Sauer, describing some interesting experiments on the visibility of ultra-violet rays, and another by M. Holz, on transformation of electric currents of low tension into disruptive discharges of higher tension.

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* As the coils were arranged in boxes, and so could not be kept at a uniform temperature, it was thought that this might be due to unequal heating. It was found, however, that the alteration in the ratio of the resistances due to this cause was such as to cause the E.M.F. to appear to increase less than it really did by about ·005 per cent. in one hour, which would not affect the results in the tables.

Der Naturforscher, September.—This number contains some interesting observations made at hot springs in Italy, by M. Hoppe Seyler, on the upper temperature-limit of life. At Ischia, on Monte Tabor, he found green algæ on the widening sides of a fissure through which rose hot steam, and the thermometer showed 64°·7 C. This was higher than in the case of algæ growing in water; at Lipari, the limit of temperature for such seemed to be about 53°.—In a lecture by M. Brefeld (given in outline), on the biology of yeast cells, the author describes the process of fructification, which is asexual, and tells how all his attempts to produce it with cultivated yeast were in vain; with the natural yeast used in fermenting wine he always succeeded.—The peculiar condition of vegetation on the sides of lakes, and banks of rivers, owing to reflection of light and heat from the water, and constancy of temperature of the latter, is illustrated by Dr. Hoffmann from a number of phænological phenomena on Lake Maggiore, the lakes of Geneva, Zurich, and other localities.—M. Felix Plateau investigates the process of digestion in insects; and M. Böhm records the gases resulting from fermentation of dead marsh and water plants; finding that these gases sometimes consist of carbonic acid, nitrogen, and hydrogen, sometimes of marsh gas with the first two. There is, he thinks, a sort of conflict between the two fermenting processes.—From accounts of the aurora of Feb. 4, 1872, Donati is led to the striking result that it was observed in different regions of the earth not in the same physical moment, but everywhere at the same local hour; as is the case with celestial phenomena which do not share in the earth's rotation. The aurora appeared first in the extreme east of the southern hemisphere, in Eden and Melbourne, and shortly after in China, whence it travelled over Asia, Europe, and America. Donati attributes the phenomenon to electro-magnetic currents from the sun.—There is also a paper on the movements of Encke's comet, by Dr. von Asten; and among other subjects treated are: insular giant reptiles, diathermancy of moist air, beats of musical tones, and the formation of meteorites and vulcanism.

Zeitschrift der Oesterreichische Gesellschaft für Meteorologie, Sept. 15.—The first paper in this number, by Herr Luedicke, of Gotha, gives an account of observations made by him on the tidal action of the moon in its several phases on the atmosphere, during a period of 100 revolutions, from Jan. 1867 to Feb. 1875. The differences between the mean heights of the barometer in the four quarters are small; the greatest difference, viz., that between the second and last quarter, amounting only to ·57 mm. The various tables given by Herr Luedicke agree, however, in pointing to the following conclusion:—That pressure diminishes with the waxing and increases with the waning moon. Comparing the means of readings nearest perigee with those nearest apogee, he finds (1) that pressure is less at perigee than at apogee; and (2) that pressure in apogee is less about the time of the equinoxes, greater about the time of the solstices, than in perigee. Lastly, taking the mean variations from the monthly mean of all observations taken in apogee and in perigee, that in perigee the excesses happen at the quadratures, the deficiencies at the syzygies; and inversely, in apogee the excesses happen at the syzygies and the deficiencies at the quadratures. These variations are rather large: for instance, in apogee at the first quarter the deficiency is 3·83, at the last 5·16 mm. It appears from all his results that the effect of the moon upon the atmosphere is exactly contrary to that produced upon the ocean, pressure being lower when the moon is near than when it is far from the earth. Tables of the varieties of weather in the four quarters are given at the end of the paper.—In the "Kleinere Mittheilungen" two articles appear on Mr. Blanford's observations in India.

Bulletin de l'Académie Royale des Sciences de Belgique, tom. xl. No. 7.—In the "Classe des Science" are the following articles:—A brief note by M. Emm. Liais, on the parallax of the sun.—A note on *Drosera rotundifolia*, by M. Ed. Morren, to which is a plate showing the structure of the different kinds of glands and hairs. M. Morren describes the capture of two insects, and especially draws attention to the way in which the glands curve in "prehension," like an animal's tongue.—M. G. Dewalque contributes a short article on lightning strokes.—M. E. Quetelet records the dip of the needle at Brussels in 1875, determined on two dates—

April 14, between 10.30 A.M. and 12.30 = 66° 56′·6
May 22 ,, 11 ,, 12 = 66° 58′·8

The diminution is at the rate of 2¼ min. per annum. The declination has been determined on three days as follows:

June 9, between 11 A.M. and 12.30 = 17° 24′·4
,, 23 ,, 10.30 ,, 11.30 = 17° 25′·1
,, ,, ,, 2 ,, 3 = 17° 26′·3

The decrease is 8¼ min. per annum. This last observation was by M. Hooreman.—M. L. Saltel contributes two mathematical papers.

THE *Journal de Physique* for September commences with a paper by M. Marey on the movements of liquid waves in elastic tubes, a phenomenon exemplified in the circulation of the blood. He applies his graphic method: passing an indiarubber tube through a series of boxes in such a way that when it expands at successive points, through passage of a wave, it presses upwards the membrane of one of the well-known monometric capsules. These successive movements are indicated, as usual, on a rotating blackened cylinder. He explains the various phenomena of positive, negative, secondary, and reflected waves, harmonic vibrations, &c.—M. Govi follows with an account of some experiments meant to prove that induced electricity of the first kind has tension. A new instrument for determining, more especially, the density of solids of which only small fragments are had, is described by M. Paquet. It is like a Baumé areometer, consisting of a pear-shaped air-vessel, weighted at the lower, narrow end with a bulb of mercury, while a thin tube rises from the upper part, surmounted by a short wider tube closed below, into which the solid fragment is put, with water. Both tubes are graduated. The density is ascertained after immersion of the instrument in water.—A valuable paper by M. de Romilly treats of the conveyance of air by a jet of air or steam, issuing from one ajutage, and entering another; several varieties of ajutage having been experimented with, and in different positions. He finds, *inter alia*, there is an integral conservation of the quantity of motion, with a conical receiver of 5 to 7 degrees, small section towards the jet-ajutage, which is placed at an exterior distance, given by the form of the jet, making a cone of about 15 degrees, the jet-orifice occupying the summit, and the receiver-orifice the base.

—M. Righi contributes a paper on an electroscope with very sensitive dry piles; its use in some experiments on electricity of contact, and on the electromotive force of heat. The journal concludes with a number of abstracts from other serials.

Bulletin de la Société d'Anthropologie de Paris, 1875.—In fascicule 4^{eme}, tome ix. 11^{e} série, M. G. de Rialle, in considering the present state of our knowledge in regard to the races inhabiting Central Asia, invites travellers to turn their attention to the study of the Herazehs, who occupy the most easterly spurs of the chain of the Paropamisus, and who still preserve many traces of the habits and traditions of the northern steppes, from which they have probably been driven by Mongol invaders. Little is known of these people, who are dreaded by the Afghans for their bravery and ferocity, and who regard themselves as allied to the Calmuks of Cabul. In the course of the discussion on M. de Rialle's paper, Madame C. Royer drew attention to the important service which travellers might render to the sciences of Comparative Ethnology and Anthropology, if they would make young children, in whom distinctions of race are most prominently exhibited, the special objects of their observations. M. Topinard, in conclusion, called upon the members of the Central Asiatic Expedition to discover whether any survivors could still be traced of the fair-skinned people described by the Chinese as inhabiting the western portion of the central plain of Asia two or three centuries before our era, and as having green eyes and red hair. Tchihatcheff asserts that he has met with red-haired individuals among the nomad Turkomans of Asia Minor, and Desmoulins believes that they are typical representatives of the primitive Turks.—In the same number of the *Bulletin* we have a summary of the views entertained by M. A. de Bertrand and others in regard to the definition and classification of prehistoric eras. M. de Bertrand, in considering the age of the Reindeer of Thurigen, suggests that we may refer the period of the introduction of polished stone into Gaul to about 3,400 years before the Christian era, and that we may possibly assume 2,000 years as the maximum of the duration of this age. His attempted determination of these periods was strongly opposed by MM. Leguay, Roujon, and others.—Several interesting reports have been laid before the Paris Society, of the numerous caves and grottoes which have been examined in the course of 1874, by M. Louis Lartet, Lagarde, and other members. The finds at Cumières, near Verdun, have been especially rich, while the explorations made at the cemetery of Curanda (Aisne) are valuable from the great variety of objects intermingled with the human remains, but owing to the successive occupation of the ground by Gallic, Romano-Gallic, and later populations, the results yield no certain evidence of the antiquity of the earlier races, whose remains are interspersed among those of definite and determinable historical character. An examination of the remains *in situ* has, however, led M. Millescamps to the important conclusion that flint instruments were cut and used as recently as the Merovingian age in France. —M. P. Broca has proposed to adopt the word "Stéréométrie" for that branch of craniometric science which treats of the determination of cranial capacities. In his paper M. Broca explains the various methods which he has found best adapted for the purpose. He considers that, of all the substances tried, bullet-lead, although not perfectly free from sources of error, is the most reliable, the results yielded by repeated experiments varying not more than five cubic centimetres for the same skull. No absolutely correct method has as yet been devised, and hence we must content ourselves for the present with approximate results.

Sitzungsberichte der Kgl. böhm. Ges. der Wissenschaften in Prag.—The publication of this Society comprises the whole of 1874, during which period some thirty important papers were read in the Natural Science Department of the Society. We notice the following:—On the independent representation of the *n*th derivative of broken functions of a variable, by Prof. Dr. Studnicka.—On the chemical composition of microsommite, by Prof. Safarik.—On harmonic systems of points on rational curves of the third and fourth order, by K. Zahradnik.—On the discovery of diluvial animal remains in the Elbe Loess, near Aussig, by Dr. Laube.—On some minerals from Kuchelbad, near Prague, by Dr. Safarik.—On the different forms and the signification of the changes in generation of plants, by Dr. L. Celakovsky.—Researches on the hyëtography of Bohemia, by Dr. Studnicka.—On the inflorescences of Borragineæ, by Dr. L. Celakovsky.—The solution of the problem of seat and essence of attraction, by Dr. Studnicka.—On the laws regulating incandescence of wires by electric currents, by Prof. A. von Waltenhofen.—Contradiction of Stieda's criticism on the author's work "On Hair," by Dr. J. Schöbl.—On a hyæna skull, by Dr. A. Fric.—On the Myriopoda hitherto observed in Bohemia, by Prof. F. V. Rosicky.—On a new universal microscope, by Prof. Zenger.—On a new photographic process to enlarge photographs correctly and to any size, by the same.—On curves of the fourth order, by Prof. E. Weyr.—On the travels of M. Emil Holub in Southern Africa, by Prof. C. Koristka.—On a new mineral mixture, named Parankerite, by Dr. Boricky.—On the theory of Cardioids, by Dr. K. Zahradnik.—On the discovery of an Ichthyomorphous *Ceratodus Barrandei* in the gas coal of the Rakonitz deposit, by Dr. A. Fric.—On the elements of a mechanical theory of ocean currents, by Prof. G. Blazek.—On the Cladocera-fauna of Bohemia, by B. Hellich. Preliminary researches on the Annelida of Bohemia hitherto observed, by F. Vejdovsky.—On the integration of differential equations of the first order, by Dr. E. Weyr.—On the pseudoscorpiones-fauna of Bohemia, by Prof. A. Stecker.—On the coal deposit of Pilsen, by Prof. J. Krejci.—Report on the chalk deposits of Perutz, in Bohemia, and their fossil remains, by the same.—On a new simple method of determining tautozonal planes of crystals, by the same.

THE August number of the *Bulletin de la Société d'Acclimatation de Paris* contains a very instructive paper, by Dr. Vidal, on the fauna and flora of Japan. The useful indigenous animals of that country are not so numerous as the geographical position of the islands would seem to indicate; the principal are a small species of ox, goats, rabbits, and wild boars. Imported animals, such as sheep and pigs, are rare, the former, indeed, not appearing to thrive in the climate, although they exist in considerable quantities on the opposite coasts of Northern China. A species of small black bear, and monkeys, are prized by the natives as articles of diet. Horses are abundant, though the ass and the mule are unknown in the country. Birds, both useful and ornamental, are very numerous, the principal being several varieties of duck and common "barndoor fowls," pheasants, and quails; wild geese are abundant, but the domestic variety and the turkey are almost unknown. Of fish there is a plentiful supply, and the fisheries form one of the most important industries of the country. Salmon are very common and highly prized.—M. L. Faton gives a summary of experiments with several kinds of vegetables and useful and ornamental plants, which is valuable as indicating the species which best repay the trouble of scientific cultivation.—At the July meeting of the Society a letter was read from M. C. Naudin, ~~enclosing seeds of *Cytisus*~~ *proliferus* from the Canary Islands, a plant which is cultivated there for the sake of its leaves, which are used as food for cattle. M. Naudin suggests that it might be usefully cultivated in France, or at any rate at the Cape of Good Hope, and in Australia.—Another plant (*Reana luxurians*), called in Guatemala Téosinté, and cultivated there for the same purposes as the one above named, is recommended by M. J. Rossignon.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. viii. fasc. xvi. The first portion of this number contains the following among other papers:—On the hydrological map of the department of Senna e Marna, by M. Curioni.—On two benzol-bisulphuric acids and their relations to other compounds, by MM. Koerner and Monselise.—The second portion of these *Rendiconti* contains reports by M. Carcano and M. Hajech, on the work of the Institute during the year; accounts of prize awards, with reports of committees on the competitive memoirs; and an announcement of prizes to be competed for within the next three years. Among the subjects of the latter we note the following:—Actual mean longevity of man in Italy, compared with other peoples; What are the best antifermentatives and antiseptics, disinfectants and deodorizers? Indicate a good method of cremation; Respective merits of animal and human vaccination; Embryogeny of silkworm; History of the progress of the anatomy and physiology of the brain, in the present century.

SOCIETIES AND ACADEMIES

MANCHESTER

Scientific Students' Association, Oct. 20.—Mr. John Plant, F.G.S., in the chair.—Mr. Wm. Gee lectured on *Polytrichum commune* (the common Hair-moss), as a type of moss-structure, commenting on the points of differentiation between true mosses and cryptogams erroneously associated with them, tracing the life-cycle, the minute anatomy of the organs, and the function of mosses in nature and art.—The Chairman exhibited a collection of Ammonites from the Kimmeridge Clay and from the Tertiary Sand near Alexandria.—Mr. C. Robinson showed local drift-shells; and Mr. Gee a miner's lamp-glass, tempered by the new process to withstand change of temperature, although of the usual thickness (¼ inch).

California

Academy of Sciences, Aug. 2.—Mr. H. Edwards, vice-president, in the chair.—Mr. Lackington presented a paper on some new Crustaceans of the Pacific coast.—Dr. Blake made some remarks on a mineral which he had presented to the Academy a few months ago under the name of Colomite. He stated that a superficial analysis of the mineral had then led him to believe that it was a potash mica, containing a very large quantity of chromium. Since that time the mineral had been analysed by Prof. Genth, of Philadelphia, who had discovered that it contained a large quantity of vanadium, more than 20 per cent. Under these circumstances he proposed to name the mineral Roscoelite, as Prof. Roscoe, of Manchester, had so successfully investigated the properties of vanadium. The mineral occurs in a gold mine in the lower hills of the western slope of the Sierra. It is associated with a small vein of quartz, but it is principally in the mica that the gold is found, a few pounds of the mineral (a miner's panful) often yielding as much as $240 in gold. The occurrence of so large a quantity of a pentivalent metalloid in a mica offers another and perhaps the most striking anomaly presented by this class of minerals as regards their chemical composition. Dr. Blake then alluded to some physiological experiments he had performed to determine the molecular relations of beryllium. Neither the specific heat of the metal nor the vapour density of its chloride had been determined, and chemists were undecided as to whether it was a bivalent or quadrivalent element. Its physiological reactions, when introduced directly into the blood of living animals, so closely resembled those of alumina that there can be no doubt but that it belongs to the same isomorphous group, and that it is a quadrivalent element. There is also a close relation between the intensity of physiological action of this substance and its atomic weight. When compared with aluminum, as in a series of experiments conducted expressly to determine this point, the quantities of Be_2O_3, under the form of sulphate, required to kill 2,270 grammes of rabbit, when injected into the veins in divided doses (three injections), were ·059, ·061, ·050; the quantities of Al_2O_3, introduced into the veins under the same conditions were ·021, ·023, ·022; and the smallest quantity required to kill, when introduced in one injection, was, of Al_2O_3, ·016, and of Be_2O_3, ·038, showing a marked increase in the physiological action of these substances, with an increase in the atomic weights, the atomic weight of Al being 27·4 and of Be, 14. This, the author believes, is the first occasion on which physiological reactions have been used to determine the chemical properties of a substance. Should, however, the carbon compounds follow the same laws in their physiological reactions as the inorganic elements, living matter must offer a valuable reagent in investigating their molecular properties. The interesting experiments of Messrs. McKendrick and Dewar, published in the 23rd vol. of the Proceedings of the Royal Society, would indicate that such may be the case, as these gentlemen found in experimenting with the compounds of the Chinolin and Pyridin groups, that the physiological actions became stronger in going from the lower to the higher members of the series. They also observed that in the Pyridin group, when the base became doubled by condensation, not only was the physiological action more intense, but its character was completely altered, agreeing in these respects with the salts of iron with which analogous changes take place, both in the character and intensity of their physiological action, when the molecule is doubled in the change from ferrous to ferric salts, as the author has shown in the *Journal of Anatomy and Physiology*, vol. iii. p. 24.

Paris

Academy of Sciences, Oct. 18.—M. Frémy in the chair.—Admiral Paris presented the volume of the "Connaissance des Temps" for 1877. This publication, prepared by M. Loery, is now double in size what it was twenty years ago, and much improved. The following papers were read:—New problems relative to the conditions of equality of size of rectilinear segments on the tangents of geometrical curves of any order and class, by M. Chasles.—Third note on the electric conductivity of bodies moderately conducting, by M. Du Moncel. In the polarisation currents obtained with silex of Herouville, he found that the electrodes do not simply play the part of conductor, but acquire a peculiar electric state, which they may retain for days, and even under intense heat; this state cannot alone produce a current of polarisation; the dielectric must have undergone electrification under influence of the electrodes. But once this has occurred, they may be separated for some time without losing the power of giving a current when brought together again. The phenomena are analogous to those of phosphorescence.—On the trepanation and evacuation of long bones in cases of osteitis of neuralgic form, by M. Gosselin.—Fall of a meteorite on 12th May, 1874, at Sersukow, in Russia, by M. Daubrée. It weighs ninety-eight kilogrammes, and is of the oligosidere type.—On the carpellary theory according to the Irideæ (second part), by M. Trecul.—On the rotatory power of quartz in the ultra violet spectrum, by M. Croullebois.—On the laws which govern reactions with direct addition, by M. V. Markovnikoff.—On a case of oxidation in the cold state, of acetic acid in neutral or weakly alkaline liquids, in presence of nitrates and phosphates of soda and potash, by M. Mehay.—Process for artificial cooling of considerable masses of air by contact with a cold liquid, by MM. Mignon and Rouart. In a candle manufactory at Amsterdam, they use a cooled solution of chloride of calcium, which descends on the uppermost of a series of plates rotated with the axis of a cylinder between discs projected from the cylinder-wall, thus giving a continuous finely-divided cascade. Through this passes 26,000 kilogrammes of air in an hour, and a building of 3,051 cubic metres' capacity has thus been kept, in September, at 12° or 13° C.—On the sexual generation of the Vorticellians, by M. Balbiani.—M. Petit and M. Godet presented notes on treatment of Phylloxera.—M. Hugo, one on a transformation of the law of Bode, regarding the distances of the planets.—M. Brachet, on an improvement of Gramme's machine, a modification in the microscope, and a process for rendering ordinary glass fluorescent.—M. Varssin-Chardanne submitted several memoirs on aërial navigation.—M. Marchand described his process of aërial navigation.—The Secretary quoted from a work of M. Mouchot's in 1869, where he refers to the ancient Roman method of utilising solar heat.—The Secretary also noticed a second edition of "Preliminary notions for a treatise on the construction of ports in the Mediterranean," by M. Cialdi.—Magnetic map of France for 1875, by M. Marié Davy. This note gives tables of declination and annual variation for different districts.—Observations of the Perseides, made on Aug. 10, 1875, at Spoix (Côte d'Or), by M. Gruey.—On a chloride of silver pile composed of 3,240 elements, by MM. Warren de la Rue and H. W. Müller.—On a successful case of trepanation for an osteitis of neuralgic form, in a flat bone—the frontal—by M. Pingaud.—On the frequency of earthquakes relatively to the age of the moon, by M. Perrez. He finds evidence that during the last century and a quarter, earthquakes have been more frequent at syzygies than at quadratures.—M. Rivet transmitted a note from Martinique on earthquake shocks there and the electric phenomena which preceded them in telegraph wires.—M. Montucci presented a note on the hypothesis of a terrestrial central fire, and M. Noirit one on an automatic dredger.

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